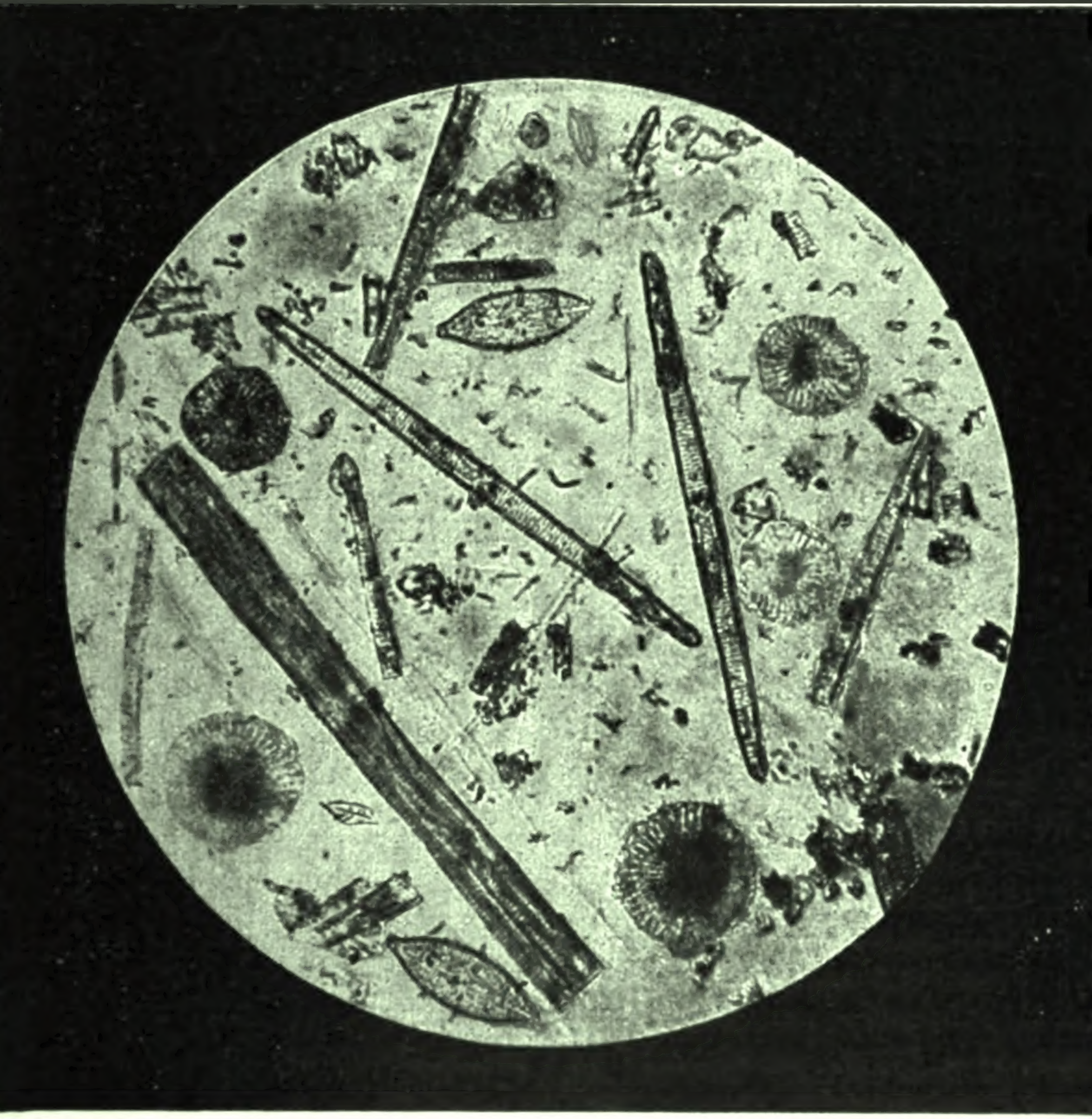

Journal of the Royal Society of Arts

Royal Society of Arts (Great Britain)

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ALPHABETICAL INDEX TO ADVERTISEMENTS.

Where no folio is given Advertisement does not appear in this issue.

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JOURNAL

OF THE

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VOLUME LVII.

FROM NOVEMBER 20, 1908, TO NOVEMBER 12, 1909.

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1909.

Journal of the Royal Society of Arts

No. 2,922. VOL. LVII.

FRIDAY, NOVEMBER 20, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

ONE-HUNDRED-AND-FIFTY-FIFTH SESSION, 1908-1909.

SESSIONAL ARRANGEMENTS.

The Opening Meeting of the One Hundred and Fifty-Fifth Session was held on Wednesday evening, the 18th of November, when an address was delivered by Sir William H. White, K.C.B., LL.D., F.R.S., Vice-President and Chairman of the Council.

PAPERS TO BE READ BEFORE CHRISTMAS.

ORDINARY MEETINGS.

Wednesday Evenings, at 8 o'clock:—

November 25.—Sir W. Martin Conway, M.A., F.S.A., F.R.G.S., "The Goldfields of Eastern Peru and Bolivia."

DECEMBER 2.—ERIC STUART BRUCE, M.A., "Mechanical Flight." WILLIAM NAPIER SHAW, D.Sc., F.R.S., in the chair.

" 9.—G. ALBERT SMITH, F.R.A.S., and CHARLES URBAN, F.Z.S., "Kinematography in Natural Colours."

" 16.—PRIMROSE MCCONNELL, B.Sc., F.C.S., "London Milk Supply from a Farmer's Point of View."

INDIAN SECTION.

Thursday Afternoon, at 4.30 o'clock:—

DECEMBER 10.—DOUGLAS DEWAR, I.C.S., "The Birds of India."

PAPERS TO BE READ AFTER CHRISTMAS.

MONSIEUR YVES GUYOT, "The Commercial Relations of France and Great Britain."

ARTHUR JOHN BARRY, M.Inst.C.E., "Railway Development in China."

WALTER ROSENHAIN, "The Application of the Microscope to the Study of Metals."

C. REGINALD ENOCK, F.R.G.S., "The Resources of Peru."

J. NISBET, "Afforestation and Timber Planting in Great Britain and Ireland."

A. E. MOORE (Secretary of the Incorporated Society for the Destruction of Vermin), "The Destruction of Vermin."

BOLTON SMART (Superintendent of the Hollesley Bay Labour Colony, Suffolk), "The Problem of Unemployment."

HENRY C. BREWER, "Gothic Art in Spain."

KRISHNA GOBINDA GUPTA (Member of the Council of India), "Some Phases of Hinduism."

DR. A. A. MACDONELL (Boden Professor of Sanskrit, Oxford University), "Early Buddhist and Hindu Architecture and Sculpture."

CECIL L. BURNS (Principal, Bombay School of Art), "The Function of Schools of Art in India."

SELWYN HOWE FREMANTLE, I.C.S., "The Problem of Indian Labour Supply."

HON. JOHN FERGUSON, C.M.G., "Ceylon, the leading Crown Colony, in 1909."

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

January 28, February 25, March 25, April 29, May 27.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

February 2, March 2, April 6, May 4.

APPLIED ART SECTION.

Tuesdays, at 4.30 or 8 o'clock:—

January 19, February 16, March 16, April 20, May 18.

CANTOR LECTURES.

Monday evenings at 8 o'clock:—

OSCAR GUTTMANN, M.Inst.C.E., F.I.C., F.C.S., "Twenty Years Progress in Explosives." Four Lectures.

LECTURE I.—NOVEMBER 23.—State of the art in 1886—Black powder—Other nitrate mixtures—Perchlorate in saltpetre—Machinery—Chlorate mixtures—"Metallic" explosives—Picric acid and picrates—Trinitrotoluol.

LECTURE II.—NOVEMBER 30.—Manufacture of nitroglycerine—Use of anhydrous sulphuric acid—Displacement process—Abolition of after-separation—Dynamites—Unfreezable nitroglycerine explosives—Guncotton—Selection of cotton—Acid mixtures—Apparatus—Percentage of nitrogen—After-treatment—Nitrostarch.

LECTURE III.—DECEMBER 7.—History of smokeless powders—Their manufacture—Flameless powders—Fulminates and detonators—Fuses—Safety explosives—What renders an explosive safe in fire-damp?—When is an explosive safe?—Coal dust—Safety explosives in practice.

LECTURE IV.—DECEMBER 14.—Use of nitrocellulose for celluloid, artificial silk, and varnish—Machinery driven by explosives—Factories: their inspection, construction, and accidents—Precautions recommended—Electric lighting—Static electric charges—The merits and demerits of explosives—Stability and its proof—Stability in practice—Accidents with smokeless powder—Stabilizers—The powder of the future.

G. L. ADDENBROOKE, M.I.E.E., "Electric Power Supply." Three Lectures.
January 18, 25, February 1.

LEON GASTER, A.M.I.E.E., "Methods of Artificial Illumination." Four Lectures.
February 15, 22, March 1, 8.

GEORGE GERALD STONEY, M.Inst.C.E., "Steam Turbines." Three Lectures.
March 22, 29, April 5.

F. W. LANCHESTER, "Aerial Flight." Three Lectures.
April 26, May 3, 10.

JUVENILE LECTURES.

Wednesday Evenings, January 6 and 13, 1909, at 5 o'clock:—
PROFESSOR CHARLES WALDSTEIN, Litt.D., Ph.D., "Digging for Ancient Art Treasures."

CONVERSAZIONE.

The Annual Conversazione of the Society will be held early in July, 1909. Each member is entitled to a card for himself, and one for a lady.

PROCEEDINGS OF THE SOCIETY.

THE SOCIETY was founded in 1754, and incorporated by Royal Charter in 1847, for "The Encouragement of the Arts, Manufactures, and Commerce of the Country, by bestowing rewards for such productions, inventions, or improvements as tend to the employment of the poor, to the increase of trade, and to the riches and honour of the kingdom; and for meritorious works in the various departments of the Fine Arts; for Discoveries, Inventions, and Improvements in Agriculture, Chemistry, Mechanics, Manufactures, and other useful Arts; for the application of such natural and artificial products, whether of Home, Colonial, or Foreign growth and manufacture, as may appear likely to afford fresh objects of industry, and to increase the trade of the realm by extending the sphere of British commerce; and generally to assist in the advancement, development, and practical application of every department of science in connection with the Arts, Manufactures, and Commerce of this country." In 1908, His Majesty the King granted the Society the privilege of adding "Royal" to its title.

ORDINARY MEETINGS.—At the these Meetings, which are held every Wednesday evening during the Session, papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed.

INDIAN SECTION.—This Section was established in 1869, for the discussion of subjects connected with our Indian Empire. Six or more Meetings are held during the Session.

COLONIAL SECTION.—This Section was formed in 1874 under the title of the African Section, for the discussion of subjects connected with the Continent of Africa. It was enlarged in 1879, so as to include the consideration of subjects connected with our Colonies and Dependencies. Four or more Meetings are held during the Session.

APPLIED ART SECTION.—This Section was formed in 1886, for the discussion of subjects connected with the industrial applications of the Fine Arts. Six or more Meetings are held during the Session.

CANTOR LECTURES.—These Lectures originated in 1863, with a bequest by the late Dr. Cantor. There are several Courses every Session, and each course consists generally of from two to six Lectures.

HOWARD LECTURES.—The bequest of Mr. Thomas Howard (1872) is now devoted to occasional courses of Lectures on motive power and its applications.

SHAW LECTURES.—Under the Shaw bequest Lectures on Industrial Hygiene are given from time to time.

ALDRED LECTURE.—The bequest of the late Dr. Aldred has been devoted to the establishment of an Annual Lecture.

JUVENILE LECTURES.—A Short Course of Lectures, suited for a Juvenile audience, is delivered to the children of Members during the Christmas holidays.

ADMISSION TO MEETINGS.—Members have the right of attending the above Meetings and Lectures. They require no tickets, but are admitted by signing their names. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor and other Lectures. Books of tickets for the purpose are supplied to the Members, but admission can be obtained on the personal introduction of a Member. For the Juvenile Lectures special tickets are issued.

JOURNAL OF THE ROYAL SOCIETY OF ARTS.—The *Journal*, which is sent free to Members, is published weekly, and contains full Reports of all the Society's Proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce.

EXAMINATIONS.—Examinations, founded in 1853, are held annually by the Society, through the agency of Local Committees, at various centres in the country. They are open to any person. The subjects include the principal elements of Commercial Education, and Music. Full particulars of the Examinations can be had on application to the Secretary.

LIBRARY AND READING-ROOM.—The Library and Reading-room are open to Members, who are also entitled to borrow books.

CONVERSAZIONI are held, to which Members are invited, each Member receiving a card for himself and a lady.

MEMBERSHIP.

The Society numbers at present between three and four thousand Members. The Annual Subscription is Two Guineas, payable in advance, and dates from the quarter-day preceding election; or a Life Subscription of Twenty Guineas may be paid. There is no Entrance Fee.

Every Member whose subscription is not in arrear is entitled:—

- To be present at the Meetings of the Society, and to introduce two visitors at such meetings, subject to such special arrangements as the Council may deem necessary to be made from time to time.
- To be present and vote at all General Meetings of the Society.
- To be present at the Cantor and other Lectures, and to introduce one visitor.
- To have personal free admission to all Exhibitions held by the Society at its house in the Adelphi.
- To be present at all the Society's *Conversazioni*.
- To receive a copy of the weekly *Journal* published by the Society.
- To the use of the Library and Reading-room.

Candidates for Membership are proposed by Three Members, one of whom, at least, must sign on personal knowledge; or are nominated by the Council.

All subscriptions should be paid to the Secretary, Sir Henry Trueman Wood, and all Cheques or Post Office Orders should be crossed "Coutts and Company," and forwarded to him at the Society's House, John-street, Adelphi, London, W.C.

HENRY TRUEMAN WOOD, *Secretary.*

CALENDAR FOR THE SESSION.

The following is the Calendar for the Session 1908-1909. It is issued subject to any necessary alterations:—

NOVEMBER, 1908.

1	**S**	
2	M	
3	Tu	
4	W	
5	Th	
6	F	
7	S	
8	**S**	
9	M	
10	Tu	
11	W	
12	Th	
13	F	
14	S	
15	**S**	
16	M	
17	Tu	
18	W	Opening Meeting of the Session.
19	Th	
20	F	
21	S	
22	**S**	
23	M	Cantor Lecture I. 1
24	Tu	
25	W	Ordinary Meeting
26	Th	
27	F	
28	S	
29	**S**	
30	M	Cantor Lecture I. 2

DECEMBER, 1908.

1	Tu	
2	W	Ordinary Meeting
3	Th	
4	F	
5	S	
6	**S**	
7	M	Cantor Lecture I. 3
8	Tu	
9	W	Ordinary Meeting
10	Th	Indian Section
11	F	
12	S	
13	**S**	
14	M	Cantor Lecture I. 4
15	Tu	
16	W	Ordinary Meeting
17	Th	
18	F	
19	S	
20	**S**	
21	M	
22	Tu	
23	W	
24	Th	
25	F	CHRISTMAS DAY
26	S	*Bank Holiday*
27	**S**	
28	M	
29	Tu	
30	W	
31	Th	

JANUARY, 1909.

1	F	
2	S	
3	**S**	
4	M	
5	Tu	
6	W	Juvenile Lecture I.
7	Th	
8	F	
9	S	
10	**S**	
11	M	
12	Tu	
13	W	Juvenile Lecture II.
14	Th	
15	F	
16	S	
17	**S**	
18	M	Cantor Lecture II. 1
19	Tu	Applied Art Section
20	W	Ordinary Meeting
21	Th	
22	F	
23	S	
24	**S**	
25	M	Cantor Lecture II. 2
26	Tu	
27	W	Ordinary Meeting
28	Th	Indian Section
29	F	
30	S	
31	**S**	

FEBRUARY, 1909.

1	M	Cantor Lecture II. 3
2	Tu	Colonial Section
3	W	Ordinary Meeting
4	Th	
5	F	
6	S	
7	**S**	
8	M	
9	Tu	
10	W	Ordinary Meeting
11	Th	
12	F	
13	S	
14	**S**	
15	M	Cantor Lecture III. 1
16	Tu	Applied Art Section
17	W	Ordinary Meeting
18	Th	
19	F	
20	S	
21	**S**	
22	M	Cantor Lecture III. 2
23	Tu	
24	W	Ordinary Meeting
25	Th	Indian Section
26	F	
27	S	
28	**S**	

MARCH, 1909.

1	M	Cantor Lecture III. 3
2	Tu	Colonial Section
3	W	Ordinary Meeting
4	Th	
5	F	
6	S	
7	**S**	
8	M	Cantor Lecture III. 4
9	Tu	
10	W	Ordinary Meeting
11	Th	
12	F	
13	S	
14	**S**	
15	M	
16	Tu	Applied Art Section
17	W	Ordinary Meeting
18	Th	
19	F	
20	S	
21	**S**	
22	M	Cantor Lecture IV. 1
23	Tu	
24	W	Ordinary Meeting
25	Th	Indian Section
26	F	
27	S	
28	**S**	
29	M	Cantor Lecture IV. 2
30	Tu	
31	W	Ordinary Meeting

APRIL, 1909.

1	Th	
2	F	
3	S	
4	**S**	
5	M	Cantor Lecture IV. 3
6	Tu	Colonial Section.
7	W	
8	Th	
9	F	GOOD FRIDAY
10	S	
11	**S**	EASTER SUNDAY
12	M	*Bank Holiday*
13	Tu	
14	W	
15	Th	
16	F	
17	S	
18	**S**	
19	M	
20	Tu	Applied Art Section
21	W	Ordinary Meeting
22	Th	
23	F	
24	S	
25	**S**	
26	M	Cantor Lecture V. 1
27	Tu	
28	W	Ordinary Meeting
29	Th	Indian Section
30	F	

MAY, 1909.

1	S	
2	**S**	
3	M	Cantor Lecture V. 2
4	Tu	Colonial Section
5	W	Ordinary Meeting
6	Th	
7	F	
8	S	
9	**S**	
10	M	Cantor Lecture V. 3
11	Tu	
12	W	Ordinary Meeting
13	Th	
14	F	
15	S	
16	**S**	
17	M	
18	Tu	Applied Art Section
19	W	Ordinary Meeting
20	Th	
21	F	
22	S	
23	**S**	
24	M	
25	Tu	
26	W	Ordinary Meeting
27	Th	Indian Section
28	F	
29	S	
30	**S**	WHIT SUNDAY
31	M	*Bank Holiday*

JUNE, 1909.

1	Tu	
2	W	
3	Th	
4	F	
5	S	
6	**S**	
7	M	
8	Tu	
9	W	
10	Th	
11	F	
12	S	
13	**S**	
14	M	
15	Tu	
16	W	
17	Th	
18	F	
19	S	
20	**S**	
21	M	
22	Tu	
23	W	
24	Th	
25	F	
26	S	
27	**S**	
28	M	
29	Tu	
30	W	Annual General Meeting

The Cantor Lectures will commence at Eight o'clock.

The Ordinary Meetings will commence at Eight o'clock.

The Meetings of the Indian Section and the Colonial Section will be held at Half-past Four o'clock.

The Meetings of the Applied Art Section will be held at Half-past Four or Eight o'clock.

The Annual General Meeting will be held at Four o'clock.

The Juvenile Lectures will be given at Five o'clock.

PROCEEDINGS OF THE SOCIETY.

FIRST ORDINARY MEETING.

Wednesday, November 18th, 1908; SIR WILLIAM H. WHITE, K.C.B., LL.D., F.R.S., Vice-President and Chairman of the Council, in the chair.

The following members were proposed for election as members of the Society:—

Abrahams, Arthur Edward, 5, Tokenhouse-yard, E.C.

Allum, Ernest Frederick, Pali Hill, Bandra, near Bombay, India.

Babington, Eustace B., Elm avenue, Long Eaton, near Nottingham.

Ballon, Walter Seymour, Providence, Rhode Island, U.S.A.

Barlet, Stéphane, 97, St. Mark's-road, North Kensington, W.

Beede, Herbert Gould, Pawtucket, Rhode Island, U.S.A.

Beesley, Frederick, 2, St. James's-street, Pall-mall, S.W.

Behrens, Captain Clive, J.P., Swinton Grange, Malton, Yorks.

Benson, Davis Edmondson, Assoc.M.Inst.C.E., 12, Irton-road, Southport.

Bharucha, Rustomji Edalji, Cumbala Hill, Bombay, India.

Booth, George T., Messrs. Booth, Macdonald and Co., P.O. Box 99, Christchurch, New Zealand.

Boyd, William Beverley, Toronto Railway Company, Toronto, Canada.

Brown, William Love, 9, Garden-street, Montclair, New Jersey, U.S.A.

Buchanan, George C., M.Inst.C.E., Chairman, Port Trust, P.O. Box 85, Rangoon, Burma, and East India United Service Club, St. James's-square, S.W.

Caddick, Arthur, Arboretum-lodge, Lincoln.

Calmon, Dr. Miguel, Gabinete do Ministro da Industria, Rio de Janeiro, Brazil, South America.

Cohen, George A., 71, Portland-place, W.

Cooper, George Seton Halcott, The Natal Brewery, Pietermaritzburg, Natal, South Africa.

Cosgrave, William A., Manipur, Assam, India.

Cunningham, William M., M.A., 174, North Fourth-street, Newark, Ohio, U.S.A.

Davis, E. A., Fernando Po, South-West Africa.

Dorn, Felix, 21, Belsize-square, N.W.

Elles, E. H., 6, Short-street, Calcutta, and Messrs. Pigott, Chapman, and Co., 1, Mission-row, Calcutta, India.

Gardner, Walter Silvester, 16, Finsbury-circus, E.C.

Garland, Frederick Joseph, M.I.Mech.E., The Water Works, Frimley-green, Surrey.

Gawthorp, Thomas George, 16, Long-acre, W.C.

Gehrke, A. H., 218, Denmark-hill, S.E.

Gray, William, 132, Packington-street, Islington, N.

Howard, Miss Rose Lilian, Apartado 1669, Mexico D.F., Mexico.

James, Sir Henry Evan Murchison, K.C.I.E., C.S.I., Glenshee, Cambridge-park, Twickenham.

Johnston, Alderman Charles, 17 and 18, Aldersgate-street, E.C.

Jones, Rev. Robert Francis, 11, Thorburn-square, Bermondsey, S.E.

Jones, W. J. H., Hurlingham-lodge, Fulham, S.W.

Kranz, William G., Sharon, Pennsylvania, U.S.A.

Lane, Hugh P., 93, Jermyn-street, S.W., and Royal Societies Club, 63, St. James's-street, S.W.

Law, William Henry, Virgil Works, 34, Eyre-street, Sheffield.

Lingham-Lees, J., B.A., Clyde-house School, Hereford.

Lloyd, Captain M. B., Messrs. Curtiss and Harvey, 3, Gracechurch-street, E.C.

Loring, Lieutenant Frederick George, R.N., 55, Oakley-street, Chelsea, S.W., and General Post Office, E.C.

Love, James Black, M.A., Tientsin, North China.

McLeod, James Morrison, 2, Hilldrop-road, N.

Majumdar, Kedarnath, M.R.A.S., Mymensingh, India.

Mallock, Henry Reginald Arnulph, F.R.S., 6, Cresswell-gardens, S.W.

Meelboom, John A., Ferro Carril Buenos Aires and Rosario, Buenos Aires, Argentine Republic.

Melville, J. Stark, 10, Blythswood-square, Glasgow.

Mesens, Mademoiselle Jeanne, 79, Rue des Rentiers, Brussels, Belgium.

Monteath, Sir James, K.C.S.I., Bellair, Charmouth, Dorset.

Moody, George H., A.M.I.Mech.E., Westholme, Bradley, Bilston.

Nariman, R. K., Assoc.M.Inst.C.E., 9, Pall-mall, S.W.

Nathani, M. R., Kiponda-road, Zanzibar, British East Africa.

Noakes, Lieutenant G. H., R.N.R., New Zealand Shipping Company, 138, Leadenhall-street, E.C.

Orr, Robert M., The United Railways of Havana, Havana, Cuba, W. Indies.

Oswell, George Devereux, M.A., Rajkumar College, Raipur, Central Provinces, India

Panter, Frederick Richard, May-lodge, Upminster, Essex.

Pastakia, Jamsetji Jejeebhoy, Kavrana's-building, Colaba, Bombay, India.

Petrie, William Wilson, 25, Finsbury-circus, E.C.

Pitt, Philip Septimus, M.A., 3, The Oval, Stafford.

Quah Beng Kee, 41 and 43, Beach-street, Penang, Straits Settlements.

Reuben, Simon, Anajee Soonder-road, Tembi, Thana, viâ Bombay, India.

Robertson, Rev. Dr. David, M.B., Ch.B., Itu, Southern Nigeria, West Africa.

Rodrigo, Arthur Colin, 15, 44th-street, Rangoon, Burma.

Seppings-Wright, F. T., Koraput P.O., Vizagapatam District, South India.

Shafi, Khan Bahadur Mian Muhammad, Baghbanpura, Lahore, India.

Simpson, Colonel C. N., Army and Navy Club, Pall-mall, S.W.

Simpson, Samuel, B.Sc., Wiswell, Whalley, Lancashire, and Zomba, Nyasaland, Africa.

Singh, Dr. Dais Raj Ranjit, L.M.S., 1, Stanley-road, Allahabad, India.

Sloper, Percy, 2, Colville-gardens, W., and Devonshire Club, S.W.

Smith, Charles H., Philippine Judiciary, P.O. Manilla, Philippine Islands.

Smith, Eden, 199, Yonge-street, Toronto, Canada.

Stanton, Albert Lennox, 13, Hyde-street, King's-road, Southsea.

Stephens, Robert, R.I.E.E., 57/2, 36th-street, Rangoon, Burma.

Steward, Henry Allan, Postford-house, Chilworth, Surrey.

Tan Jiak Kim, The Hon., Panglima Prang, 115, River Valley-road, Singapore, Straits Settlements.

Tattersfield, George H., 20, Kenilworth-court, Putney, S.W.

Thanewala, Maneck K., 438, Thakoredwar, Bombay, India.

Thomas, R. G. D., 8, Mission-row, Calcutta, India.

Tremlett, Washington, 13, Rue Auber, Paris, and 41, Conduit-street, W.

Un Yuen Hsu, B.A., care of Chinese Legation, 49, Portland-place, W.

Venn, John Augustus, Onitsha, Southern Nigeria, West Africa.

Wang Tahsieh, His Excellency, 2, Lancaster-place, Belsize-square, N.W.

Watson, Professor William Franklin, A.M., Furman University, Greenville, South Carolina, U.S.A.

Welchman, Mrs. B. de Vere, The Close, Exeter.

Westwood, Ernest Herbert Wyndham, A.M.I.E.E., Orontes, 140, Barkly-street, St. Kilda, Melbourne, Australia.

Winstanley, Herbert, Beddington-lane, Beddington, Surrey.

Wood, Thomas A., Nairobi, British East Africa.

Young Hee, M.R.S I., Kia Ora, 18, Kennedy-road, Hongkong, China.

The CHAIRMAN delivered the following

ADDRESS.

My predecessors in this Chair, as a rule, have merited the distinction by long and faithful service to the Society. All of them have expressed high appreciation of the honour done them by their colleagues on the Council. On the present occasion my acknowledgments must be even greater, and my gratitude deeper, since no claim to similar good service to the Society can be made on my behalf. All that I can claim is that my connection with the Society goes back nearly half a century, commencing with an appearance as a candidate at its examinations when a boy in Devonshire. The certificates which I gained are still treasured, and the acquaintance which then began with the educational work of the Society impressed upon my mind respect for its scope and character which has deepened as knowledge has increased. I esteem it a privilege, therefore, to be permitted to assist the Society in any way, and the Council and members may be assured that during my period of office everything in my power shall be done to promote its interests.

It is not necessary on this occasion to enter into details of the various and important departments included in the work undertaken by the Society. The story has been told by others whose knowledge and authority on the subject are superior, and the facts are readily accessible. I would venture, however, to refer to one aspect of the operations of the Royal Society of Arts, since it leads naturally to the subject with which this Address will be principally concerned. The Society has always been ready to give assistance and hospitality to younger and struggling associations, established for the cultivation of branches of science and technology. In this way it has rendered possible new departures and promoted the growth of knowledge. It has been my fortune to be connected intimately with many engineering and scientific bodies; but that which naturally stands first in order of date, and closest in interest, is the Institution of Naval Architects. From its foundation in 1860 up to the present time the annual meetings of that institution have been held in this hall by the courteous permission of the Council, and in other ways the success attained has been due, in no small degree, to facilities afforded by the Royal Society of Arts. On behalf of my fellow members of the Institution of Naval Architects I now offer our sincerest thanks; and, in doing so, only record the sentiments of many other societies which have received similar assistance.

My first appearance in this hall was about Easter of the year 1865 in the capacity of a student of the Royal School of Naval Architecture and Marine Engineering. That school had been established in 1864 as the result of action taken by the Institution of Naval Architects on the initiative of the late Mr. Scott Russell, who had read a paper here emphasising the fact that no adequate means of instruction in

the principles of naval architecture then existed in this country, and that the need ought to be met immediately. Thus stimulated, the Admiralty and the Education Department joined forces and set up at South Kensington a school which did excellent work during the nine years of its existence, and yielded fruits of which the influence has been far-reaching. It is no far-fetched idea, therefore, which leads me to say that to the Royal Society of Arts and to the assistance which it gave from the first to the Institution of Naval Architects I and my fellow students in the Royal School of Naval Architecture are indirectly indebted for our professional education. The remarkable growth of scientific method in the practice of shipbuilding and ship propulsion which has marked the last half century may be attributed to the same causes; and thus the Royal Society of Arts may claim a share in promoting a movement which had much to do with the commanding position now occupied by British shipping amongst the war fleets and mercantile marines of the world.

In these circumstances it has occurred to me that an appropriate subject for the Address, which it is my duty to deliver as Chairman of the Council, might be found in a brief account of the methods adopted for the education of naval architects in this country during the past century. I venture to hope that, apart from its particular interest for those engaged in shipbuilding, the narrative may have some value and attraction for those interested in technical education generally; and that it may throw some light on problems of higher technical education which still await solution in this country.

In 1806 the Commission of Naval Revision reported in the following terms in regard to the principal shipbuilding officers of the Royal Navy:—"In the whole course [of training and promotion] no opportunity will be found of acquiring even the common education given to men of their rank of life; and they rise to the direction of the construction of ships, on which the safety of the Empire depends, without any care or provision having been taken on the part of the public that they should have any instruction in mathematics, mechanics, or in the science and practice of marine architecture." There is evidence too that outside the Admiralty service the standard of professional attainment amongst British shipbuilders was even lower. As practical ship-carpenters they excelled: their ships were "well and truly built," strong and durable. As ship-designers they depended on precedent and experience. British war-ships were designed in accordance with "Established Dimensions," according to which ships of a certain tonnage carried a certain number of guns of specified sizes. The tonnage was estimated by an unscientific rule; and a competent authority, speaking of the condition of things existing at the beginning of the last century, asserted that "scarcely an individual in the country knew correctly even the first element of one of our numerous ships." As a matter of fact the official "Established Dimensions" were varied but little from 1680 to 1810, and there was practical stagnation in British shipbuilding. New ships were either copies of their predecessors, or were but slightly varied. For example, a design prepared in the Admiralty for a 74-gun ship in 1759 was used again and again up to 1782, no less than thirteen vessels being built in accordance therewith. This was not an exceptional occurrence in these "good old times." The lot of an Admiralty constructor was then a happy one as compared with present days when ships are sometimes treated as "obsolescent" as soon as they are completed, and incessant change is the dominating condition in naval construction.

Instead of advance having been made in the practice of naval architecture in this country during the eighteenth century, there is reason to believe that there had been retrogression, so far as scientific knowledge and methods were concerned. Phineas Pett, who designed the famous *Sovereign of the Seas* in 1637, was a Master of Arts of Cambridge University as well as a master shipwright. Pepys records in his Diary that Sir Anthony Deane (another famous master shipwright of the seventeenth century) could "cast the draught of water which a ship will draw beforehand;" in other words, could estimate the total weight (displacement tonnage) of a new design. Evelyn confirms this statement, describing a book on ship construction of which Deane was the author as "an extraordinary jewel." No doubt men of this sort were exceptions rather than average representatives of British shipbuilders of the period. Another master shipwright of 1668 was described by Evelyn as "Old Shish, a plaine honest carpenter . . . . hardly capable of reading, yet of great ability in his calling." But the Petts and Deanes showed a better way, which unfortunately was not followed, and the Commission of 1806 reported accordingly. England, which had become a great school for shipbuilding in the

latter half of the seventeenth century, and which had achieved a reputation sufficient to attract Peter the Great as a student, had fallen behind France before the nineteenth century began. When French ships were captured they were often taken as models for new British ships. It is stated that when an English fleet chased a French fleet, the latter, as a rule, showed superior sailing qualities. The explanation of this superiority in French designs is undoubtedly traceable to an earlier adoption of scientific methods in that country.

When Louis XIV. determined to create a powerful fleet, his Minister, Colbert, encouraged mathematicians and men of science to investigate the fundamental laws of ship construction, in order that these laws might be applied in practice. The Academy of Scinces offered prizes for the best essays on subjects connected with naval architecture, and threw the competition open to the world, thus inducing Daniel Bernoulli, Euler, and distinguished men of science in other countries, as well as many Frenchmen, to make contributions. The education of naval architects also received careful attention; and from all these efforts the improved practice above-mentioned became established in French naval construction.

Although British shipbuilders did not advance as rapidly as their French rivals, the progress made by the latter was not unmarked in this country, nor were efforts wanting to advance scientific knowledge. Some translations of foreign treatises on naval architecture were published in the latter half of the eighteenth century. One of the earliest was due to Mungo Murray, who is said to have lived and died as a working shipwright at Deptford. Original work was also done by English writers on the subject, amongst which Attwood's "Disquisition on the Stability of Ships"—published in the Proceedings of the Royal Society (1796-98)—deserves honourable mention. In 1791 a "Society for the Improvement of Naval Architecture" was established, with a large and influential membership. Under its auspices Colonel Beaufoy conducted an important series of experiments on fluid resistance to the motion of solid bodies. The results are still of value, and the methods adopted were correct in principle. It is of interest to note in passing that only this year a German experimentalist, who was not acqainted with Beaufoy's methods, again suggested their adoption, adding, of course, many improvements in mechanical details and means of accurate observation and minute measurement which have been made available by the progress of invention during the last century.

The movement in favour of better education for British shipbuilders and the adoption of scientific methods in ship design a century ago, was chiefly due to men unconnected with the industry, and was not welcomed by shipbuilders of the older school. Fortunately opposition from various quarters was overcome, and the first School of Naval Architecture began its work at Portsmouth in January, 1811, under the direction of Doctor Inman, a distinguished graduate of the University of Cambridge. His first care was to select a textbook on the theory of naval architecture for the use of his students, and his choice fell on a Swedish treatise—Chapman's "Architectura Navalis Mercatoria"—which was translated into English and carefully annotated. An interesting side-light has been thrown upon the then existing situation, by an article contributed to one of our reviews, some years ago, by the late King of Sweden, who called attention to the fact that the author (Chapman) was of English extraction, and had found more honour in Sweden than in the country of his origin.

Dr. Inman proved an able teacher, and many of his pupils did honour to his instruction in their subsequent professional careers. The intention was to train men who should unite sound practical experience with high scientific knowledge; to give them employment subsequently at sea, and in the work of ship-designing; and so to provide efficiently for the higher ranks of officers at the Admiralty and in the Royal Dockyards. Lord Melville, who was First Lord from 1812 to 1830, strongly favoured the school. It was generously treated during the twenty-one years of its existence; forty students passed through it, and over £50,000 was expended upon its maintenance. In 1830, Sir James Graham became First Lord, and two years later, the School of Naval Architecture was abolished, while a naval officer was appointed Surveyor of the Navy, the highest office to which a naval architect could then aspire, and one supposed to be charged with direct responsibility for the designs of all ships for the Royal Navy. For many years Dr. Inman's pupils consequently had practically no opportunity of demonstrating their capacity to perform the duties for which they had been trained, but were employed in subordinate positions.

When the steam-reconstruction of the Navy had to be undertaken about fifty-five years ago, and was rapidly followed by the use of armour as a protection against attack by explosive shells, it became impossible any longer to pretend that naval officers, untrained as naval architects, could undertake the responsible work of designing British war-ships. Fortunately, trained men were available in the persons of Dr. Inman's old pupils, who had been compelled to wait twenty years before their opportunity came. One of them, Mr. Isaac Watts, became Chief Constructor, and was aided by a group of his own fellow-students. Another, Mr. Lloyd, became Engineer-in-Chief of the Navy. Outside the Admiralty service, conspicuous success was attained by other trained naval architects. Mr. Creuze was appointed to be the principal technical officer to Lloyd's Register of Shipping, and produced a treatise on shipbuilding which has become a classic. Mr. Moorsom originated the modern system of tonnage measurement for merchant ships, which still bears his name, and has become universal in mercantile fleets. As soon as opportunity offered these trained naval architects showed their mettle—remedying abuses, introducing improvements, solving new problems, assisting the development of British shipbuilding, and placing it once more in a good position relatively to that of other maritime countries. In France, the great naval architect, Dupuy de Lôme, encouraged and supported by the Emperor Napoleon III., achieved marked success; first, in the design of steam line-of-battle ships, next in the design of armoured floating batteries used during the Crimean war, and finally in the production of sea-going ironclads. But each forward step made in France was matched or surpassed by action taken by Great Britain, under the technical guidance of Isaac Watts and his coadjutors. Amongst the latter it is but right to say that many eminent private shipbuilders and marine engineers were numbered, to whom was due no small share of the credit of introducing iron as a material for shipbuilding and the rapid progress made in steam propulsion.

Sixteen years elapsed before a second School of Naval Architecture was established by the Admiralty at Portsmouth, under the title of the "Central School of Mathematics and Naval Construction." Five years earlier the Admiralty had framed a scheme for schools in the Royal dockyards, at which all apprentices were required to attend "every afternoon for three hours, commencing an hour and a half previous to that at which the yard closes." Under this rule the Admiralty paid the boys' wages for one-half the period of school attendance, and required them to give the other half out of their own time. Beginning with "elementary matters, such as reading, writing, common and decimal arithmetic, Scripture, English history and geography," the apprentice passed on to more advanced instruction. At the end of three years a selection was to be made by means of an examination, and those whose abilities entitled them to a higher course of instruction were allowed to attend school for two years more. For the majority of apprentices this ended their education; but the Admiralty order provided that "two or three of the best apprentices in each yard should be elected to the first class, should be instructed in 'laying off' and the leading principles of ship construction, and, so far as it is necessary for that purpose, should be taught mechanics, hydrostatics, and mathematics." To whom such a complete and well-considered scheme for training apprentices, foremen, and higher officers in the Admiralty shipbuilding department was originally due it is not now easy to ascertain. Its main features have been continuously maintained for sixty-five years, with results which more than justify any expenditure incurred. After fifty years' working it was reviewed by a Special Committee appointed by Lord Spencer when First Lord, in order to ascertain whether or not the enormous advances made since 1843 in the provision for elementary education had justified some radical change in the dockyard schools or their abandonment. The verdict of the Committee was unanimously in favour of the continuance of the schools, and this verdict was based on conclusive evidence of the benefits which had resulted therefrom, not merely to the national dockyards but to the private shipbuilding industry. As the national standard of elementary education had been raised, so the required standard for the admission of apprentices had been elevated, and out of the dockyard schools there had come multitudes of well-educated intelligent workmen; from amongst whom, by a process of gradual selection, had been found subordinate and principal officers for the Admiralty service; while no small number had passed from that Service into the private trade, and occupied positions of importance and responsibility in shipyards throughout the country and on the staffs of the registration societies for

shipping, of which Lloyd's Register is the greatest. No doubt the Admiralty has not always administered all its affairs in so perfect a manner, or shown such prevision as has been displayed in regard to their educational scheme which has been described in outline. It is but fair, therefore, to give credit where credit is due; and in this case it is beyond question that the Admiralty showed the way to all large employers of labour. The scheme is broad and generous; it gives facilities and aid, while requiring apprentices on their side to study in time that would otherwise be their own for leisure or recreation. It carries on, side by side, practical and educational training; it exercises a gradual selection of those whose ability and application show them to be capable of benefiting by higher instruction. It sets up a "ladder of learning" from the lowest level; and there has been no bar to any capable man in striving to reach the highest position. Its cost is extremely moderate in proportion to its beneficial results. For the current financial year the dockyard schools at home and abroad are estimated to cost less than £6,200, while the wages vote for these establishments exceeds two and a-half millions sterling. In recent years schemes of a somewhat similar nature have been adopted by some large employers—including railway companies—with results that are declared to be satisfactory so far as experience has been gained. The advocates of such schemes may take courage from the long-continued success of the dockyard schools, of whose existence they may not even have heard. Indeed it is singular to discover how little recognition there has been during discussions on technical education, of work initiated by the Admiralty at a time when national education was less considered. This work has been carried on with changes in details, but not in principles up to the present day; and that fact must be my excuse for dwelling upon it now.

The second School of Naval Architecture constituted, as has been stated, the final stage in the Admiralty scheme for the technical education of its naval architects. Its students were intended to be the pick of dockyard apprentices of five years' standing, who during that period had received an excellent general education, a good training in the practice of shipbuilding, and a special course of mathematics bearing on naval construction. It differed from the first school, therefore, because the former institution had been intended exclusively for a higher class of apprentices, to whom appointments were guaranteed when their course of training was satisfactorily completed. In other words the fundamental idea of the first school was to train students who were intended to become superior officers subsequently. On the contrary, the working apprentice class, by a process of selection applied at intervals during five years, was intended to supply the students to be trained in the second school, and they were not guaranteed appointments similar to those promised to their predecessors.

The first school was in fact a large scale experiment in a direction which has found favour in many quarters, the fundamental idea being to fill the higher professional offices from the well-to-do and liberally educated classes, leaving only subordinate positions open to the poorer and working classes. The second school was frankly democratic, and the results obtained compared favourably with those obtained by its predecessor. No one will dispute, however, that a preferable system is that which admits, on equal terms, properly qualified students drawn from all classes of society, and secures for all the same opportunities for instruction.

Cambridge University again supplied a Principal for the School of Naval Construction in the person of Dr. Woolley, who proved a worthy successor to Dr. Inman. During the five years of its existence men were trained who subsequently achieved high distinction in the theory and practice of shipbuilding, and who proved capable of taking up the primary responsibility for war-ship design when age and failing powers compelled the retirement of men trained in the first school. Amongst them may be mentioned the late Sir Edward Reed, Chief Constructor of the Navy from 1863 to 1870, and the first Secretary of the Institution of Naval Architects, which owed much to his energy and ability; Sir Nathaniel Barnaby, who succeeded him and performed the duties of Director of Naval Construcfion with conspicuous success until 1885; Mr. F. K. Barnes, late Surveyor of Dockyards, whose recent death at a ripe old age has recalled attention to his valuable contributions to ship-calculations, and especially to those relating to stability, trim, and buoyancy; Mr. J. B. Crossland, who showed much originality as a mathematician; Mr. Henry Morgan, for many years a Chief Constructor at the Admiralty, and many others well known in the profession. The grave responsibilities incidental to the

iron-clad reconstruction were borne, and successfully borne, by these men for a period of more than twenty years; and it was a fortunate circumstance that the Central School of Mathematics and Naval Construction was in existence even for so brief a period, because its students ably filled the gap, that would have otherwise existed, in the ranks of trained naval architects at a most critical period in our naval history.

Sir James Graham abolished the second school as he had done with the first about twenty years earlier. A diligent search through his recently published biography has not enabled me to discover what reasons moved him to this action, other than a desire for economy. It may be doubted, however, whether any real economy was thus obtained, and efficiency was certainly sacrificed; while the national reputation was endangered, and an admirable scheme of technical education was deprived of its final and most important stage. Fortunately (and again for reasons not now discoverable) the dockyard schools were spared. The fact that a statesman so eminent and progressive as Sir James Graham undoubtedly was, should have failed to perceive that his action marred an admirable scheme, is itself a proof of the change of opinion that has taken place during the last half century in regard to the value of technical education.

The third School of Naval Architecture, as already stated, was founded in 1864, and placed at South Kensington, the Education Department being associated with the Admiralty in its establishment and maintenance. Its creation was due to the action of the Institution of Naval Architects, which had been formed in 1860, on the joint initiative of naval architects trained for the Admiralty service, of a number of leading private shipbuilders and marine engineers, and of naval officers, yachtsmen, and men of science. In many respects the Royal School of Naval Architecture and Marine Engineers differed from and was more comprehensive than its predecessors. This was natural, seeing that it was organised in the manner described, and on the basis of experience gained in two previous schools. Dr. Woolley, who had been serving as Inspector of Admiralty Dockyard Schools since 1853, was fortunately able to take a prominent part in its organisation. He was appointed Inspector-General and Director of Studies, had much to do with the choice of the staff and the settlement of courses of studies, and took an active interest in the well-being of the school throughout its existence. To him British naval architecture owes a deep debt of gratitude. His influence secured the cordial assistance of many scientific men who were leading authorities in various branches of science having close relation to the work of building and propelling ships.

The new school was intended to train students for the private industry as well as for Admiralty service. Its founders hoped to attract the sons and relatives of shipbuilders and marine engineers, as well as to provide for young men selected by the Admiralty from the dockyard schools. Marine engineering was recognised as the younger sister of shipbuilding, needing equally good and systematic training for those making it their career. Foreign students were admitted as well as British subjects. The institution was designed to be, or to become, a school of which the greatest maritime nation of the world might be proud. It started under the fairest auspices; there was no failure in organisation, courses of study, teachers or lecturers; the Admiralty played its part and sent up well-prepared students; foreign Governments also sent students, but in regard to private British students there was disappointment, both as to numbers and previous preparation. What should have been the chief source of supply for British students, and for income, failed lamentably. Looking back on the result, it does not appear so surprising as it did at the time. The scheme of instruction was admirable, only it required for its good working a standard of previous attainment, which was reached only by Admiralty students who had spent five or six years in practical work at the dockyards, and in attendance at the special schools therein provided. Even the best of the private students were far less advanced on entry; consequently very few of them were able to benefit fully from the higher and specialised instruction provided at South Kensington. Many private students did derive advantage from attendance, and have shown this to be true in their subsequent careers. On the whole, however, it must be admitted that the scheme was pitched too high in relation to the means of preliminary instruction then existing in this country; and that to give it full effect a preparatory school should have been created also, through which students could have passed before proceeding to the Royal School of Naval Architecture. Even to this day, one of the greatest difficulties in the way of utili-

sation by students of the higher instruction provided in technical colleges, consists in the want of proper preparation. The standard for entry is being raised gradually, no doubt, but teachers and students both suffer from the cause that has been named, and it is one of the crying needs in the national system of education. Forty-four years ago the position was much worse.

The course of study in the Royal School of Naval Architecture included all branches of mathematics having relation to the designs of ships and engines; practical chemistry, carried on in a laboratory attached to the school; physics, metallurgy, mechanism; and detailed instruction in ship and engine design. In addition, there were special courses of lectures, open to the public as well as to students, and the situation of the school in London enabled it to secure the assistance of men of the highest eminence in various branches of science. The Astronomer-Royal lectured on the errors and corrections of the compass in iron ships, Mr. Scott Russell on fluid resistance and the wave-line theory, Mr. William Froude on the stability and oscillations of ships, Professor Rankine on ship propulsion and strength of materials, Dr. Percy on metallurgy, naval experts on gunnery, and members of the constructive department at the Admiralty on various questions connected with the construction and equipment of ships. The regular staff of the school was composed of men of proved ability selected by Dr. Woolley. The principal, Mr. Merrifield, was a mathematician of repute; the vice-principals were men who had taken high mathematical honours at Cambridge, the first of them having been Senior Wrangler the year before he was appointed. In all respects the provision made was generous, except in buildings, which were of a temporary character. Even in this particular, however, the scheme was intended to be worthy of the greatest maritime nation, as will be understood when it is added that the fine building in the Exhibition-road, long devoted to the College of Science and School of Mines, was planned as the home of the Royal School of Naval Architecture, but was still incomplete when the Admiralty, in 1873, decided to make provision for the training of their naval architects and marine engineers in a department of the great Naval College which was to be established at Greenwich.

During the nine years of its existence at South Kensington the Royal School of Naval Architecture had an entry of 119 students, and 24 of these were transferred to Greenwich. Of the 95 students who completed their training, 53 were naval architects and 42 marine engineers. In the first School of Naval Architecture 40 students had been trained in 20 years, in the second about 20 students in five years, all for the Admiralty service. At South Kensington 57 students were trained for the Admiralty service in nine years, and there were thirty-eight private students. Fourteen private students were foreigners—six from Russia, two from Holland, five from Egypt, one from Norway. Very few of the British private students came from the great shipbuilding and engineering establishments, although attractive scholarships and studentships were offered. At that date most of those responsible for the conduct of private firms obviously did not set much value upon the specialised instruction which the school was established to provide; and this circumstance had much to do with the decision to abolish the school taken in 1873.

One must plead guilty to partiality, no doubt, when attempting to appraise the value of work done at the South Kensington school, if one has been—as I have—both student and teacher there. It was my fortune three years after the completion of my studentship, in 1867, to be appointed teacher of naval architecture. It is permissible, however, to mention facts as to the subsequent career of students of that school. Two of them in succession have occupied the responsible post of Director of Naval Construction at the Admiralty, and two others that of Engineer-in-Chief to the Royal Navy. Another has been charged with the arduous duties of Director of Dockyards. Others have served with distinction in the higher offices of the Constructive and Engineering Departments at the Admiralty and in the Royal Dockyards. Many men originally trained for the Admiralty have passed over to private industry, and have undertaken the responsible management of leading shipyards and engine factories, or have been charged with difficult problems connected with the technical business incidental to the working of Lloyd's Register of Shipping and other Registration Societies. Abroad ex-students of the school have risen to similarly important positions and given proof of the value of their training. No one dreams of claiming for the Royal School of Naval Architecture any monopoly of influence in the advancement of scientific methods in

shipbuilding and engineering. Much of this advance has been due to enlightened efforts of private shipbuilders and marine engineers who were not trained in the school. On the other hand it is certain that the influence of that school has been great, and its founders have good reason to be satisfied that their labour was not in vain.

Although the South Kensington School was abolished, no break in the provision of instruction in the science of shipbuilding and engineering was involved in the transfer to the Royal Naval College. The Admiralty regulations for the new establishment provided for the admission of private students who had been properly prepared and were fitted to benefit by its educational facilities. Avowedly the main purpose of the Royal Naval College was the training of men for the public service, but moderate fees were charged to private students, and scholarships as well as free studentships were offered for competition. For many years free permission was given for foreign students to enter, although at a later date—and for reasons which it is unnecessary to state—that permission was withdrawn. The mathematical and technical instruction of the students of naval architecture and marine engineering was provided for by a separate professorial staff; but the laboratory and other instruction in chemistry and physics of these students was undertaken by professors and assistants who also taught naval officers passing through the college; and in these respects there was an improvement on the arrangements at South Kensington. It was also possible to extend and improve the curriculum in ship and engine design, and to give more time thereto; but in the main features there was continuance of the methods proved to be suitable during the previous nine years.

It was my privilege to be continued in charge of the instruction in naval architecture, and to be given considerable freedom in arranging the courses of study at Greenwich, where I continued at work until 1881 concurrently with my duties in the Constructive Department of the Admiralty. There are certain distinctive features in the arrangements at the Royal Naval College which have stood the test of thirty-five years' experience, and consequently may be worth consideration by those engaged or interested in technical instruction elsewhere. To a few of these I would refer, because they have a bearing on higher technical education in its general aspect.

First.—Great care is taken thoroughly to prepare the Admiralty students before they enter the College, so that they may derive full advantage from the special facilities existing there. For many years past the Admiralty has maintained at Devonport a College in which those who are to become engineer officers of the Navy receive a practical and scientific training extending over four or five years. Entry to this school has been governed by competitive examinations, and the parents of students have been required to contribute to the expenses of the education of their sons; so that the selection of the students has been made from a higher class than that which furnishes ordinary dockyard apprentices. The arrangements already described for educating these apprentices in special dockyard schools have been maintained and improved; and from amongst the apprentices who showed the greatest ability during their course of study a limited number has been selected and given Admiralty scholarships in the Engineering College, where they have resided for some time and completed their preparatory education in company with the engineering students. At the end of the training in this preparatory college a final selection is made of a limited number of students of naval architecture and marine engineering, who proceed to the Royal Naval College to undergo a further period of three years' training in the higher branches of their profession. These selected men, having received a preparatory education of a very special character, are ready to proceed at once with the higher studies, which embrace mathematical, scientific and professional subjects bearing upon their future work. During the three years' course at the college the summer vacations of the students are spent in the Royal dockyards on practical work, so that Admiralty practice for about forty-four years has represented what is now termed the "sandwich system" of instruction, and it has worked well. The Admiralty, being a great employer, can readily make these arrangements. Other large employers may benefit by following similar methods, and not a few have already done so in principle, although the details of their schemes differ.

Second.—Private students admitted to the Naval College have been required to possess and give evidence of possessing a knowledge of practical shipbuilding obtained by a period of service in shipyards, as well as a certain standard of attainment in mathematical and

scientific subjects. It may be observed that this combination of preliminary practical experience and scientific knowledge received the support of a representative committee on engineering education (consisting of delegates nominated by all the great engineering societies in the United Kingdom) appointed during my Presidency of the Institution of Civil Engineers. Of this committee I acted as chairman. The committee was itself both strong and representative, while it took pains to ascertain the opinions of a very large number of the leading civil engineers in practice throughout the country. There was a consensus of opinion in favour of the arrangement just mentioned, and all youths aspiring to become engineers are advised to pass through a period of service in shipyards, workshops, or factories before beginning their higher technical training at universities or colleges. In Germany a similar condition has been insisted on in recent years, and a period of practical training must be undergone by every student who aims at any branch of engineering as his life's work, in the interval between leaving the secondary schools and entering the higher technical schools. I am aware that some persons hold a different opinion on this matter, but their claim to authority can hardly be treated as equal to that on the other side. How can a mere expression of opinion be fairly set against long experience of the other plan in Admiralty establishments? Personally, while admitting that every rule has exceptions, I feel confident that the Admiralty system above described is best suited to the needs and capacity of the average student and best combines those practical and theoretical attainments which are equally essential to an educated engineer.

Third.—The teachers of naval architecture and marine engineering at the Royal Naval College are officially called "Instructors," but really perform the duties of professors. They are appointed only for limited periods, coming from and returning to their professional work. All of them have been distinguished graduates of the college; and, after the completion of their studies, have acquired considerable practical experience at the Admiralty, in the dockyards, and (in many cases) during periods of service at sea. Thus equipped they enter upon their work as teachers. The naval architecture classes at the Royal Naval College have two instructors at work simultaneously. The junior instructor is wholly employed at Greenwich; he acts as assistant to the senior in teaching ship design and calculations, and has independent charge of special classes established for the instruction of naval officers in the principles of ship construction and propulsion. The senior instructor gives only part of his time to the college, and the remainder to his work as a member of the staff of the Constructive Department of the Admiralty, where he is actually engaged on ship designing. A man has to prove his capacity for teaching as a junior before he is considered eligible for the senior position. Between these two stages of educational work he has to return to actual employment at the Admiralty or in the dockyards. In this manner it is ensured that teachers never "lose touch" with the practical side of their professional work, and shall never continue so long in the position of instructors as to become stale, and therefore less capable of dealing with the professorial duties entrusted to them. Everyone who has considered the matter will, I think, agree that there may well be an essential distinction between the periods of continuous service of professors of pure sciences in technical universities and colleges and the professors of applied sciences. For the latter an intimate knowledge of the conditions of current practice and the latest improvements is of the highest importance, and they must not be dissociated from professional work. On the other hand, professors of pure science may well make original investigation and instruction given to pupils the work of their lifetime. For professors of applied science, the course taken by many gentlemen has much to commend it. After having served as teachers for many years and achieved distinction, they have voluntarily resigned their positions and have returned to practical work, although there was no sign of failing power. Subsequent performances have fully justified their action, and their professorial chairs have been filled by others bringing fresh minds to the task. Too long continuance in teaching applied science is to be deprecated both for professors and pupils.

Care seems to be required also in another direction at the present time, when rapid extensions of technical education bring with them large demands for qualified teachers. There is a danger that men of the student class may be passed directly into the position of assistants to professors of applied science without having gained much, if any, acquaintance with practical work, and subsequently may become professors without gaining experience of that kind. This is clearly undesirable and

should not be permitted. No teacher of any branch of engineering can be regarded as properly qualified until he has gained actual experience and borne the burden of responsibility in connection with the design and execution of important works. It should never happen that those who teach should be lacking themselves in one side of the training—and that the not less important side—which, by common consent, is needed for the modern engineer. The Admiralty system meets this requirement, and has worked well. It has furnished capable professors of naval architecture and marine engineering, not merely for Admiralty establishments but for Universities at home and abroad.

Turning to results obtained from the work of the Royal Naval College during the last thirty-five years, it must suffice to say that they have been altogether satisfactory when judged by the positions which have been or are occupied by men who graduated there. The Admiralty staff of naval constructors and marine engineers has been mostly recruited from that source, and the highest offices have been successfully filled by ex-students of the Royal Naval College. Amongst these may be mentioned the present Engineer-in-Chief of the Royal Navy, the Director of Dockyards, and the majority of the staff in the Constructive and Engineering Departments at the Admiralty and at the Royal Dockyards. As in the South Kensington School, so at the Naval College, it has happened that some of the most distinguished students originally trained for the Admiralty service have passed into private employment, and at the present time occupy some of the most important positions in the private shipbuilding and engineering establishments of the country, and on the staff of great registers of shipping. Foreign students of the Naval College have also achieved distinction; amongst them may be mentioned gentlemen who have held the offices of Chief Constructor of the United States Navy, the Director of Naval Construction in the Danish Navy, the Superintendent of the great experimental establishment at the Washington Navy Yard, and others who have done original work of great value. Private students of the Royal Naval College have been more numerous and more successful than those of the Royal School of Naval Architecture, as might have been expected from the great advances made in technical education in recent years, and from the insistence by the Admiralty on a higher standard of qualification as a condition of admission to the college.

It may be interesting to add that about twenty-five years ago the Admiralty constituted a Royal Corps of Naval Constructors. The scheme for that corps, with the preparation of which I was much concerned, provided for the admission of qualified men who had not received their training under the Admiralty, or in Admiralty establishments, subject to the condition that candidates for entry showed proof (by examination, and by recorded service) of thorough training in both the science and practice of shipbuilding. Up to that time, as will have been gathered from what has been said in this Address, all officers in the shipbuilding department of the Admiralty had to pass through the apprentice class; but when the Admiralty established an engineering college at Devonport, and provided also for the entry of the sons of parents whose means sufficed to pay for the education given, the pre-existing narrow limits of selection were swept away. Those students who distinguished themselves at the Royal Naval College became eligible for admission to the Constructive Corps; and it was laid down that any qualified candidate trained in private establishments, who could pass the standard, and furnish proof of practical training, might also be appointed to the corps. This scheme, therefore, threw open to all classes of naval architects who cared to qualify the possibility of entering the Admiralty service. The process of entry was not an easy one, and should never be made so. The work to be done by the Constructive Corps is of a character and involves responsibilities which demand the best efforts of thoroughly trained naval architects. The competition for entry from amongst those trained by the Admiralty has always been severe, and they will probably continue to furnish the greater proportion of the members of the Constructive Corps, more especially as the openings in private establishments are more numerous, and the financial prospects more attractive. It has now been for many years the rule to admit all the classes specified on equal terms, and I am glad to say that the Constructive Corps numbers amongst its members at the present time many capable men who have been drawn from outside the Admiralty service. At the same time the door still remains open for the admission of those who by sheer ability and application have proved themselves worthy to be advanced; and the Admiralty has not departed from its

traditional policy of permitting those who prove themselves capable, to pass from the apprentice class in the dockyards up to the highest ranks in the shipbuilding and engineering branches of the naval service.

Closely allied with the scientific education of shipbuilders and marine engineers is the provision for instruction of naval officers and shipowners in the fundamental principles governing the construction and propulsion of ships. As regards officers in war-fleets and in mercantile marines, it is advantageous that they should possess some knowledge of the principles of buoyancy, stability and structural strength, and should have mastered the elements of engineering. On the side of shipowners similar knowledge would undoubtedly assist commercial success. From the nature of the case shipowners must determine the governing conditions of the trades in which ships are to be employed, and naval architects must discover the best possible solutions of the problems laid before them. In the case of war-ships, naval officers properly claim the right to select the qualities of armament, protection, speed, coal endurance, &c., which they wish to have embodied in designs. It is equally undesirable for the naval architect to assume the right of laying down the conditions to be fulfilled in new designs, as it is for shipowners or naval officers to assume the position of amateur ship designers. In the last century much was done in the way of building experimental vessels, for which designs were at least nominally originated by amateurs; and the tendency to recur to similar procedure is by no means extinct. But if naval offieers or shipowners can be endowed with an understanding of the elementary principles affecting ship construction and propulsion they must be better able to appreciate what is or is not possible under the conditions of practice; and therefore they will be much less likely to lay down conditions which are incompatible with one another or impossible of realisation. These considerations led me to suggest in 1873 that the Department of Naval Architecture in the Royal Naval College at Greenwich should include classes in which officers of the higher ranks in the Royal Navy should receive elementary instruction of this kind. These classes have now been in successful operation for more than thirty years, and there is ample evidence of their utility. The experience of large numbers of naval officers of various ranks who have passed through these classes shows that what was hoped for has been realised, and that the Royal Navy has benefited greatly from the instruction received. Subsequently to the establishment of these classes at Greenwich it was decided also to give systematic instruction to junior naval officers in the principles of shipbuilding and engineering, and good results were obtained. In the most recent arrangements for the education of naval officers at Osborne and Dartmouth, fuller expression has been given to the same idea, and no one questions the advantages which will be gained thereby. In these days it is obviously a necessity that every naval officer, charged with the great responsibilities attaching to the use and management of war-ships which are full of complicated machinery, should possess a considerable knowledge of engineering. The only matter on which difference of opinion exists is in regard to the further training of that class of officers who will eventually be placed in responsible charge of the propelling and other machinery of war-ships. Into that matter I do not propose to enter in the present Address. All that need be added in this connection is that experience in the Royal Navy fully justifies the recommendation which I have made to the authorities of Universities where higher instruction in naval architecture and marine engineering has been provided or contemplated, viz.: that it is desirable to establish also classes in which less advanced instruction might be given to officers of the mercantile marine, or to those who propose to take an active part in the management and ownership of ships. The objection which has been raised to such a course on the ground that it might lead to that "little knowledge" which is "dangerous,", has been met by long experience at the Royal Naval College.

Although distinct from the special subject of this Address, it may be permitted to make brief allusion to the effect produced upon the advance of modern shipbuilding by evening classes in naval architecture established under the auspices of the Science and Art Department (now the Board of Education). Large numbers of youths and young men of the artizan class have there been taught the principles of naval architecture. For many years these classes have existed in the dockyard towns of the south of England, and in the great centres of shipbuilding. They have given useful instruction to draughtsmen and men engaged in the practical operations of the shipyard, and from amongst these, by a process of selection, no small number of men

have been found who were capable of receiving higher training, and rising to positions of primary importance in the private shipbuilding industry. In later years, municipal technical schools, in our great seaports, have given a home to these classes, and at the present time they are flourishing more than ever. In this department of technical education the United Kingdom has a distinct advantage over any other maritime country, and it has had a marked effect upon the more general adoption of scientific methods in shipbuilding during the last thirty years. To those who have watched events closely and sympathetically, this side of technical education has been of the greatest interest. It is not, of course, limited to shipbuilding, but includes many other subjects. Thirty years ago, the drawing offices of the private shipyards of this country engaged in the construction of cargo steamers—which may be called the "staple industry" of British shipbuilding—were conducted in a manner absolutely different from that which now prevails. It is within the truth to say that, at the present time, scientific skill and ingenuity are being displayed in the design of the much despised tramp steamer, or pure cargo-carrying vessel, no less than in the designs of the swiftest and largest passenger steamers, and of the most powerful war-ships. Signs of increasing recognition of the value of these evening classes are to be found in the large number of scholarships, exhibitions, and studentships which have been founded in recent years by the generosity of public bodies, or private individuals. The Committee of Lloyd's Register of Shipping, the Institution of Naval Architects, the Shipwrights' Company, and other associations have aided the movement. Young men whose first training was received in these classes, are now actively engaged throughout the shipyards of the country, doing good service, and assisting to maintain our supremacy in shipbuilding. In order to maintain that universally desired result, the best brains of the country must be utilised, and all classes of the community must be drawn upon. The contemporaneous provision of elementary and advanced instruction, and of means by which students of naval architecture can pass from the lowest rung of the ladder to the topmost, are outstanding features of the last thirty years, and are matters for congratulation.

From the preceding remarks it will be understood that the sole provision made for the higher education of British naval architects for a very long period was in schools established by the Admiralty; but this reproach was removed about a quarter of a century ago by the creation of a Professorship of Naval Architecture in the University of Glasgow, thanks to the generosity of Mrs. John Elder. The chair was first occupied by Dr. Elgar, and he has been succeeded by the late Professor Jenkin, and by the present occupant, Professor Biles. All three are distinguished graduates of Admiralty schools of naval architecture, and have a record of practical achievement matching their scientific acquirements. The Glasgow classes have trained large numbers of men, including many foreign students, who are now occupying good positions in the profession at home and abroad. About the same time a Professorship of Engineering was established in connection with the University of Durham at the College of Science (now the Armstrong College), Newcastle-on-Tyne, and instruction in naval architecture are included in the curriculum of studies in this department. It was always desired to have an independent professorship of naval architecture in this great centre of shipbuilding, and by persistent effort this desire was fulfilled about a year ago. In this instance also the professor was chosen from the ranks of men trained by the Admiralty, Professor Welch having been a student at the Royal Naval College, and having served for years in the Constructive Department. The country now possesses three schools of naval architecture, two of which are independent of the Admiralty, and sustained by the private shipbuilding industry. It has been long my hope that a third school may find a home in the University of Liverpool. The matter is under consideration, and I trust it will be brought to a successful issue before long.

It has been suggested that the multiplication of schools of naval architecture in Great Britain may be overdone; but when compared with the provision now made for the education of naval architects in Germany, France, and the United States, and taking into account the overwhelming preponderance of British shipowning and shipbuilding there need be no fear that four schools of naval architecture, each with a considerable number of students, would constitute an excessive provision for this country. In the Technical High School of Charlottenburg near Berlin there were not long ago about 400 students of naval architecture and marine engineering, all of whom had received adequate preparatory training before entering the High School and specialis-

ing in these studies. Even at the present time the total number of equally qualified students of naval architecture and marine engineering attending the classes in British schools is only about 170, or less than one half the number of men studying at Charlottenburg. In the United States excellent schools of naval architecture exist at the Massachusetts Institute of Technology and as departments in several universities. These are well equipped and attended by considerable numbers of students. When it is borne in mind that the aggregate tonnage of steamships belonging to the British Empire is 17,000,000 tons as against 3,705,000 tons owned by Germany and 1,542,000 (exclusive of the shipping on the great lakes) owned by the United States; and that in 1907 the gross tonnage of ships launched in the United Kingdom aggregated 1,608,000 tons, as against 291,000 tons for Germany and 486,300 tons for the United States, it will hardly be maintained that the provision made or contemplated for the higher education of British naval architects is likely to prove excessive.

Possibly it may be thought that the German provision for such education is extravagantly large, and that the number of highly-trained men who annually pass out from the High School at Charlottenburg is in excess of the real requirements of the shipbuilding industry of that country. This is not the opinion entertained in Germany itself; for another school of naval architecture has been created at Dantzic recently. The view taken in Germany seems to be this:—In order to secure the best talent in sufficient quantity for the efficient conduct and development of shipbuilding it is desirable to train a large number of men, and to select the most capable of them for leading positions, leaving the less successful students to find their way either into subordinate positions or into other departments of industry for which their training may fit them. One obvious result of training large numbers of men is that in all grades of the supervising staff in German shipyards well-educated men can be found, and no one can doubt that this confers substantial advantages. On the whole it may be concluded that what has been done up to date in this country, and all that is contemplated in the immediate future for the higher education of naval architects and marine engineers is more than justified by experience. In educational matters a generous view is always to be commended, and the law of the "survival of the fittest" should have free play. That law, as will be seen from what has been said, has been applied by the Admiralty for more than sixty years in the training of their naval architects, and has yielded good results. It is in force too in all the great shipbuilding and marine engineering establishments of the country, although not specifically laid down. Under the stress of ever increasing competition its application is essential to the future industrial standing of our country and of the British Empire.

The last half century has witnessed unprecedented progress in British shipping and shipbuilding. It is apt to be forgotten that when the Civil War broke out the tonnage of American shipping was rapidly overtaking that of this country and threatened to surpass it before long. It is true, no doubt, that the lead which we took in the use of iron instead of wood as the chief material of construction and in the development of steam navigation, helped forward the remarkable progress that has been made. It is equally true that great assistance to progress has been given by the application of scientific methods to ship construction and propulsion. It would be ridiculous to suppose that the contemporaneous development of technical and scientific training amongst naval architects and marine engineers had only been a coincidence and had not played a great part. Naval architects are always glad to acknowledge their great indebtedness to men who were not, strictly speaking, members of their profession—men like Isambard Brunel, Sir William Fairbairn, William Froude, Rankine. Nor do the naval architects trained under the Admiralty fail to recognise the valuable contributions to progress made by professional colleagues whose whole careers have been run in private establishments. Many circumstances, as well as many persons, have assisted in bringing British shipping and shipbuilding into its present unrivalled condition, but the underlying and predominant cause must be found in the general recognition of the necessity for scientific, as well as practical training, on the part of those engaged in the design and construction of ships and their machinery.

Ship-designing can never be dealt with on purely scientific methods. Exact estimates cannot be made of the most trying conditions to which ships at sea may be subjected. Accumulated experience, based on careful observation and experiment, must always be the foundation of successful work. Direct

experiments on models of ships and propellers are of incalculable value. But the arrangement and conduct of these experiments, the carrying out of observations on the behaviour of ships, the grouping and analysis of results, and the deduction therefrom of facts and principles for future guidance, all demand scientific knowledge and scientific procedure. Of course, this is not peculiar to shipbuilding, and I have no desire to magnify the importance of that branch of engineering to which my life has been devoted. It is equally true of engineering as a whole, and of the applications of science to industrial processes generally. My chief object in describing to-night what has been done in the technical education of naval architects, has been to present an object lesson to those interested in technical education as a whole. My hope is that the experience which has been described, and which probably covers a longer period than any other system of higher technical education that exists in this country, may prove of some service in assisting the solution of present-day problems.

After delivering the Address, the Chairman presented the Society's medals which were awarded for papers read during last Session.

At the Ordinary Meetings :—

To Sir Edward W. Brabrook, C.B., for his paper on "Old Age Pensions."

To Monsieur Lucien Hubert, Député des Ardennes, for his paper on "The Rôle of France in West Africa."

To Mr. C. E. Kenneth Mees, D.Sc., F.C.S., for his paper on "Screen-Plate Colour Photography."

To Mr. Robert Buchanan, for his paper on "The Application of Science to Foundry Work."

To Mr. William Martin, M.A., LL.D., for his paper on "The Law of Treasure Trove."

To Prof. H. S. Hele-Shaw, LL.D., F.R.S., and Mr. Douglas Mackenzie, for their paper on "The Problem of Road Construction with a view to Present and Future Requirements."

To Mr. Ernest R. Matthews, F.R.S.E., Assoc.M.Inst C.E., for his paper on "The Use of Reinforced Concrete in Engineering and Architectural Construction in America."

To Mr. Lovell N. Reddie, for his paper on "The Gramophone and the Mechanical Recording and Reproduction of Musical Sounds."

In the Indian Section :—

To Mr. Henry Staveley Lawrence, I.C.S., for his paper on "Indian Agriculture."

To Sir David W. K. Barr, K.C.S.I., for his paper on "Progress in the Native States of India during the past Forty Years."

To Sir James John Digges La Touche, K.C.S.I., for his paper on "The United Provinces of Agra and Oudh."

In the Colonial Section .—

To Mr. A. Berriedale Keith, M.A., B.C.L., for his paper on "The Development of Colonial Self-Government in the 19th Century."

To Sir Hanbury Brown, K.C.M.G., for his paper on "Irrigation in Egypt under British Direction."

To the Hon. C. H. Rason, for his paper on "The Mineral Resources of Western Australia."

To Mr. Richard Jebb, for his paper on "The Imperial Problem of Asiatic Immigration."

In the Applied Art Section :—

To Mr. Lewis Foreman Day, F.S.A., for his paper on "How to Make the Most of a Museum."

To Mrs. Hadaway, for her paper on "Developments in the Art of Jewellery."

To Miss Isemonger, for her paper on "Lace as a Modern Industry."

Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., in proposing a cordial vote of thanks to Sir William White for his interesting and instructive Address, said that if the Chairman had shown at one time the singular incapacity of the British public for making use of the scientific intelligence they had at hand, he had also shown how easily and rapidly a portion of them were capable of retrieving their blunders. He had given in his Address many instructive hints about technical education, and had taught them a great deal on the question of the teaching of applied science. At the beginning of his address he depreciated his own position as Chairman in comparison with his predecessors; but on behalf of the Society, he (Sir Steuart) wished to say that the honour was with the Society in receiving the services of a man of such distinction; and if their gratitude had not been for favours received, there would still be that shadow of it which depended on favours to come. He was sure the Society would profit and progress under Sir William's auspices, and he wished him a happy and successful reign.

Sir Philip Magnus, M.P., in seconding the motion, remarked that Sir William had given in his address a great deal of information in respect to a branch of technical education with which many present were not well acquainted; but, nevertheless, a branch of the utmost importance to this country, seeing the extent to which its security depended, not only upon the number of its ships

but also upon their perfection of construction. He had shown how the evolution of the war-ship had been almost exclusively brought about by the students of the School of Naval Architecture and the Royal Naval College, where he had performed very important duties; and the experience he thus obtained had enabled him to give most valuable advice to other persons and societies actively engaged in the consideration of important educational problems. Sir William had incidentally referred to some of those problems in connection with technical education which were still unsolved problems having a very distinct relation to other branches of manufacturing industry than those to which he had devoted so large a portion of his life. Among those problems he had referred to the great importance of combining theoretical education with practical training, and he had shown how that might be done in the case of students, the excellent example having been given of what was being done in Germany; while, at the same time, he had dwelt upon the extreme importance of care being taken that the professors and teachers, in the technical institutions, should never lose touch with practice, but should always be in the front of the industry, in the technology of which they were giving instruction. He (Sir Philip) had the very great advantage of serving, with the Chairman, on the Departmental Committee which was appointed to consider in what way the Royal College of Science, and other institutions, could be brought together in a great School of Science and Technology, and it was unnecessary for him to mention the valuable services Sir William rendered upon that Committee. That valuable service still continued, to the great advantage of the School and the country, for Sir William had been made one of the governing body of the Institution.

The resolution of thanks was carried by acclamation.

The CHAIRMAN, after thanking the mover and seconder for the kind words they had used, and the audience for the hearty manner in which the proposition was received, said he had a very strong feeling with regard to national education on its technical and industrial side. He did not agree with the depreciatory terms in which British technical education was so often described as compared with foreign systems, and he had a strong conviction that it was not as bad as it was painted. As this nation had in industry, commerce, shipping and navigation, taught the world so much, he thought it should not be ashamed to learn something in its turn; and wherever there might be any useful lesson to be learned abroad, where those who had been pupils of the British people had improved upon British methods, naval constructors would be foolish if they did not profit by their experience and ability.

TELPHERAGE: SOME MODERN ROPEWAYS.

The word used in the heading of this article, has not become so familiar to the general public as its original introducers anticipated, and it is, therefore, as well to repeat the definition of the word, given by Professor Fleeming Jenkin, in 1884. In an able paper, before the meeting of the Society of Arts, for May 14th of that year, the professor, while explaining the reasons which led him to introduce a new word, concisely defined the meaning, as "all modes of transport effected automatically with the aid of electricity." In those days, it was held to include electric railway lines, as they were called; but modern usage has assigned to it a more limited province, as being concerned, particularly with overhead rope conveyors and single line small-carriage aerial railways, without admitting passenger lines (which are not numerous, the Eberfeld-Barmen line being the only one which occurs to the mind) at all. This probably arises out of the conversion of existing institutions—such as the tramway and railway—to electrical working, with the consequent inheritance of a large proportion of the old terms.

In attempting, however, to define the limits of this province of engineering, we are at once confronted with an apparent breakdown of the original definition. Professor Jenkin's original idea was apparently to drive the wheel running on the wire on rails, in the same manner as a locomotive propels itself by turning its driving wheels. This system, though satisfactory enough on a line running at approximately the same level, would not work when the gradient were heavy. As aerial railways are so eminently suited to mountainous countries, where frequent and heavy gradients are involved, development of this system has been in the direction of runways, or shop and yard conveyors, which practically belong to the order electric crane.

The intention in the originator's mind was, apparently, a method of conveying goods over considerable distances by means of a suspended carriage or conveyor, not necessarily having a man in itto control the speed. In one of the latest scientific discussions on the subject, on the occasion of a paper on "Ropeways," before the Institution of Civil Engineers read by Mr. John Macdonald in April, 1904, Mr. A. S. Clift gave the definition as follows:—"A telpher line was a cableway with the auxiliary hauling cable omitted." In this case the term would be allowed to include ropeways in which the motive power is furnished by electricity, as well as the carriage moved by electricity along a rope or rail from which it is suspended.

The system which appears most nearly to coincide with the original idea (and with the experimental line erected at Glynde in Sussex, by Professor Jenkin and that on Mr. Pryor's estate, described by Professor Jenkin in his introductory paper of 1884), is that in which a carriage runs upon a stiff overhead rail, and

is propelled by the turning of the wheel from which it is suspended. Current for the motor is taken by means of a trolly arm from an auxiliary wire. Professor Jenkin estimated that the cost of transport on a five-mile line of this kind, having on it 25 carriers, for a speed of four miles an hour, would be ·604 of a penny per ton per mile; 15 cwt. was to be loaded on each carrier. The original cost of the installation was taken at £8,000, and, allowing for interest, depreciation, generating, and all other expenses connected with the work, he estimated the total cost per ton mile at 2·09d. It will be interesting to see how far this is borne out by the working of existing examples, allowing for the facts that, at the time Professor Jenkin was speaking, coal was lower in price, and electrical machinery dearer and less efficient.

A good example of a true telpher line is that at the Bevan works of the Associated Portland Cement Company. Nearly all the machinery of this works is driven electrically, and it, therefore, was natural, when a conveying line had to be planned, to select a system in which this was the motive power. The line had to pass over a mill and some warehouses, and to rise 52 feet from the water-level up to hoppers. It is required for conveying coal from barges to these receptacles.

The design and erection of the line was the work of Messrs. Siemens Bros., on whose works at Woolwich a similar line is in operation. The rail is supported by an I beam measuring 15 inches by 5 inches, and this beam is supported by side-brackets from cross-beams, which have perpendicular girders at either end. The total distance travelled is 100 yards. The line rises from the water front by a gradient of 1 in 55, and, on reaching the required height continues level. The telpher is a steel-framed truck with two wheels, each driven by a separate motor, from which hangs the cage having in it a hoisting drum, motor, and complete controlling gear, also space for the men directing the operations of the telpher. From the cage hangs a grab, whose capacity is one ton of coal. The running speed of the telpher is a maximum of 750 feet per minute ($8\frac{1}{4}$ miles per hour) with an average of 600 feet per minute (nearly 7 miles per hour). The hoist is at the rate of 60 feet per minute. The weight of the whole apparatus with load, is 7 tons. The telpher takes power from an auxiliary wire by means of a trolley arm. It is counterbalanced by a weighted rope which it picks up; this contrivance would not so easily be effected in a line of considerable distance. The power consumed is given as $\frac{3}{4}$ unit per ton of coal delivered. The capacity is 400 tons per day. It is difficult to compare this short distance with the figures before given, and the gradient and lifting gear further complicate matters. However, it will be noticed that with electricity at 1d. per unit the cost per mile is largely in excess of that given above.

Probably the best known example of a telpher in this country is that at the Victoria Station, Manchester. This is suspended from two rails hanging from the roof of the station, each $\frac{3}{4}$ of an inch thick by $4\frac{1}{2}$ inches deep. It is in the form of a carriage having a lifting gear from which is suspended a basket whose maximum load is 30 cwt. Its limit of travel is 300 yards. It runs about 100 miles per week, and the cost is given as 1s. 6d. per day for electricity. This would work out as nearly as possible at a penny per ton mile for electricity. It will be noticed that the cost of current even for the most modern line exceeds that of the original estimate. It is probably considerations of this kind, as well as of construction, which account for the rarity of a true telpherage system. In mountainous and difficult districts, the cost of making accessible the places for the supports can be very little less than that of an ordinary light railway, and the comparison in the quantity of material which can be carried is all in favour of the latter. There is also the difficulty of the gradient to be surmounted.

A line very closely allied to a telpher, and constituting, more accurately speaking, a gigantic crane, is used in Palmer's shipbuilding yard at Jarrow-on Tyne. Here there are three lines of cables attached at either end to carriages working on horizontal cross-girders. These cross-girders (100 feet long) are supported at either end by a column, each 125 feet high. The end cross-girders and their supports incline outwards, and are hinged at the base thus keeping the cables taut. In addition to the working cables, two other cables connect the cross-girders together to provide against accident. The cableway has a clear span of 505 feet by 100 feet wide. The operater travels in the cage of the load carriage and thence controls all the motions of the apparatus. The travel is up to 600 feet per minute, the hoist 150 feet per minute. This is evidently an enormous crane under which an entire ship may be built.

In the construction of bridges, cableways are often employed. For the high-level bridge at Newcastle-on-Tyne, a main rope was suspended over 1,520 feet span, and a carriage hauled backwards and forwards by an auxiliary rope, worked by an electric motor of 100 B.H.P., thus constituting a cableway, as distinct from a ropeway, where the suspending rope itself moves. The load which could be handled was 10 tons, and the speed of travel 300 feet per minute; hoist, 75 feet per minute. The main rope was $9\frac{1}{2}$ in. in diameter, and the stress upon it when loaded amounted to 90 tons.

A similar apparatus on the Brother's system was used to construct the railway bridge over the Zambesi, near Victoria Falls. The span here was considerably less, being 870 feet. The load was 10 tons, hoist 20 feet per minute, and travel 300 feet per minute. One tower from which the cable hung was pivoted, and inclined outwards, in the same way as in the Jarrow installation. Current was conveyed to the cage along an auxiliary copper wire.

The ordinary type of slow-moving rope conveyor operating over a short distance possesses few features of interest; it usually consists of an endless wire rope

running on pulleys and driven by a steam engine, on the same principle as the cable tram. A recent example, that installed at Barnsley Main Colliery, passes over the public road, which here passes over the Midland Railway. The ropeway is here provided with a screen to protect the road from falling material, the screen being of the nature of a light bridge of 80 ft. span. The object of the line is to convey coal, at the rate of 50 tons an hour, from the colliery washery to a bunker near one of the coke ovens, over several obstacles, such as a boiler-house, and the bridge before-mentioned. The total length is about 420 feet.

In countries where means of communication are plentiful, however, the need for the rope-way is limited. It is in mountainous districts where railways are rare that this contrivance becomes most useful. A very good example of such a ropeway is to be found in India, at Kotagudi, in North Travancore. The problem in this case was to convey goods from a river in the valley to an estate in an elevated position (3,932 feet above the river) and *vice versa*. The expense of carriage was considerable, and the loads necessarily limited. The engineers (Messrs. R. F. Thorp and W. Kent) therefore decided to construct a ropeway on the endless rope system, having electricity as a motive power. The ropeway is divided into two sections, each complete in itself, thus obviating the great weight of a single rope. The power station is about ¼ mile up from the foot of the ascent. The motors are two in number; the ropeway requires 12½ horse-power when light, and 27 horse-power when conveying 15 tons each way. Electrical current for driving the motors is transmitted on 27/13 cables, each a mile in length. It is derived from a power-house which takes its power from a waterfall by means of two Pelton wheels, each 2 feet 6 inches in diameter, working at 800 revolutions per minute. The effective head is 720 feet, and a supply of 80 cubic feet of water per minute will develop, with both wheels working, 80 horse-power. The pressure pipe is 8 inches in diameter, and its length 1,500 feet. The wheels drive two dynamos, which give 40 amperes each at 500 volts, when run at 1,100 revolutions per minute. It will be seen that the dynamos are capable of developing nearly 53·6 horse-power, which, allowing for a loss of 10 per cent. in the transmission line, would give about 48 at the motors. The suspending cable is about 2⅞ inches in circumference, and has a breaking strength of 25 tons. The maximum load per carriage is 3 cwts. Loads 20 feet long can be carried on two carriers. There are nine standards to the upper section, and fifteen to the lower.

The first cost of this line was £8,300. Annual maintenance and working expenses are £1,874 10s.

Conveying loads from a low position to one at a considerable elevation above it may be said to have been the problem which caused cable-ways to have been invented. They have been in use for many years in the Welsh slate quarries for this purpose, and thence have been applied to shallow mining and industrial short transit lines practically all over the world. Probably their most orthodox application is for bridge, dam, and reservoir construction. A modified form is used in America for hauling logs to the saw-mill. One end of the cable is attached to an unfelled tree, and the felled timber drawn to the mill by means of a carriage slung on this cable. Another use of the cable-way, is that introduced by the Temperley Conveyor Company, for coaling ships at sea. The cable in this case is kept uniformly taut by a compensating engine which automatically pays out and hauls in the cable as required by the shifting of the ships. The coal is conveyed in bags, and two hauling ropes are used, one to transmit, and one to return. The claim for this system of 100 tons an hour conveyed seem modest when battleships of carrying capacity of 6,000 tons have to be considered. The possible applications of the cable-way as a slow speed conveyor are extremely numerous. At Vouvery, in Switzerland, one was used in the construction of an hydraulic pipe-line.

One of the most important of modern cable-ways, is that which connects the Anmetz mine with the Friede furnace of Kneutlingen, Lorraine. This cable-way consists of a double steel rope cable supported on steel towers, over which runs the tractive rope, and on which travel skips or buckets filled with ore, at a rate of 2·5 metres per second (a mile in 10½ minutes). At the loading and unloading ends are tramways on which trucks are run under the skips. The quantity transported reaches the enormous total of 5,500,000 ton kilometres per annum. The distance over which the ore is conveyed by cable-way is 10·75 kilometres, so that we have roughly some 1,500 tons conveyed per working day. This quantity is exceeded at Rombach, where it is reckoned 2,000 tons per 10 hour day are carried, but the distance of this latter cable-way is only two kilometres.

At Kneutlingen the supporting steel towers are in most cases 100 metres apart (325 feet) but spans vary up to as much as 300 metres (975 feet). The line needs very little power, there being a total fall of 145 metres, and the loaded side can therefore assist materially in pulling the returning skeps. The motive power is supplied by electro-motors, worked from the generating station of the ironworks.

While on this subject, it is not amiss to notice that very fascinating scheme which embodies the underlying idea of the original telpherage, viz., the Taeggi Electric Post. Signor Piscicelli Taeggi was the inventor of a system in which two rails were to be attached on a bracket carried by a pole similar to a telegraphic-pole. On these ran a carriage, taking current from a wire above the rails, and returning it through a wire below them. This system was considered by the Italian postal authorities, but we do not know of any instance where it is in practical use. Current was to be supplied at high tension, and trans-

formed down to 250 volts for running use. It was expected to realise speeds as high as 400 kilometres (240 miles) per hour by this device. Considering it is an extension of the cash-railway system, there seems no obvious impossibility in it.

INJURIES TO SUBMARINE CABLES.

The Inter-Departmental Committee on Injuries to Submarine Cables (Chairman, Sir J. C. Lamb, C.B., C.M.G., formerly Second Secretary to the Post Office) have issued their report to the Postmaster-General.

The terms of reference of the Committee were as follows:—"To inquire whether injury is caused to submarine cables by the operations of trawlers, and, if so, to consider and report what steps it is desirable and practicable to take to prevent such injury."

The Committee have examined 25 witnesses, representing the principal telegraph companies and the trawling industry of Great Britain and Ireland. The representatives of both sides were present together, and had the opportunity of clearing up doubtful points in each other's evidence. The report is summarised as follows:—

SUMMARY.

(A) The Committee are of opinion that injury is sometimes caused to submarine cables by otter boards of certain types and boards out of repair, and by beam trawls with defective trawl-heads.

(B) They think that there would be little risk of injury from trawls of either kind if they were always suitably constructed and in good condition.

(C) They find that the owners of trawling vessels are generally willing, and indeed anxious, to modify their trawling gear with the view of minimising the risk.

(D) They are not prepared to recommend the proscription of any area beyond territorial limits.

(E) They recommend that all cable companies should (as certain companies and the Post Office have already done) establish friendly relations with the fishermen who frequent the waters in which their cables are laid; while the fishermen on their part should try to clear their trawls when they foul a cable, and should report the position of any contact with a cable.

(F) They recommend that a system of Government inspection of the gear of trawlers be at once instituted.

(G) They recommend that steps be taken through the diplomatic channels to invite neighbouring foreign States to adopt a similar system of inspection.

(H) They think that eventually an international conference may be necessary to settle the terms of a convention on the subject.

(I) They recommend that the cable companies should consider the question of substituting heavier types of cable in the areas affected.

ARTS AND CRAFTS.

A New Morris Tapestry.—Since the collapse of the Windsor Tapestry Works, tapestry making on anything like a large scale in this country has been practically confined to the workshops of Messrs. Morris and Co. Their work, therefore, has a very special Interest, and, since their tapestries have of recent years been so exclusively from designs by Sir Edward Burne-Jones, it is somewhat of a shock to come across one not only designed by some one else, but also, comparatively speaking, pictorial in character. In the early days of the manufacture, pieces were made after designs by Walter Crane and Philip Webb, but that is such ancient history that most people have forgotten it by this time. Obviously Messrs. Morris and Co. could not go on reproducing old designs indefinitely, and, once they had come to an end of their Burne-Jones drawings, they were obliged to look round for something which, while fresh and in a sense new, did not depart too widely from the lines which they had laid down for themselves. Of course, work like the modern Gobelins would have been quite outside their range. They have always worked on lines decorative rather than pictorial, and that from conviction quite as much as, or more than, from necessity. They were bound to their own traditions without being tied to slavish copying of what they had done before. A design, then, by Mr. Heywood Sumner, carried out in Morris tapestry, is somewhat of an event. It marks the beginning of a new departure, and one of which all those concerned in the day-to-day history of arts and crafts in this country must take notice. It is interesting to see how Messrs. Morris and Co. have begun to solve the difficult problem of finding designs to follow without imitating those of Sir Edward Burne-Jones, and encouraging to note that they have made so satisfactory a start. That the change should involve some difference in treatment and point of view is only what was naturally to have been expected. Probably no two artists have ever had, or ever will have, quite the same point of view; so much the better for those who look at their work.

Mr. Sumner's standpoint is, of course, always decorative, and it is a little odd that this design should be rather more pictorial in feeling than a good deal of his work. The treatment of the subject in this case is by no means flat, or so flat as one would have expected the artist to make it. The tapestry is called "The Chace," and it is certainly well named, for not only does the central subject represent a hunting scene, but the border is made up of panels each of which helps to carry on the main idea. We have, all round the edge, pictures of animals chasing other beasts or birds smaller than themselves. The fox, for instance (a very wonderfully modelled fox, by the way), chases the pheasant, the dog pursues either the cat, who in her turn is after the woodpecker, or a squirrel who is turning his kind attentions to a jay, and so on. All round the frame the instincts of the chase in the different kinds of animals is shown and made use

of. The hunting scene itself is somewhat odd in its construction, as, though it contains two huntsmen, or a huntsman and his attendant, they are relegated to the side of the picture, and the main interest seems to centre in the two enormous beech trees, in all the glory of a conventionally red autumn foliage, which stand in the middle of the composition. The colour scheme is decidedly interesting and affords a good deal of scope. Not only is there great variety in the tone of the tree trunks in the foreground, but the distant landscape and the purple heather in the middle distance afford more opportunities of delicate and rich colouring which have certainly not been missed. The feeling of life and go expressed in the human figures is carried through the rest of the picture by a pack of hounds all quivering with vitality and eager for the chase, who are scattered over the foreground. It is as unusual as it is interesting to find a piece of tapestry so pictorially decorative in feeling. This is first and foremost a picture—a picture with lights and shades and varying distances —but it is for all that a truly decorative piece of work. If there seems no special reason why it should have been produced in tapestry rather than some other medium, one certainly does not feel that it in any way suffers from the material in which it has been executed. It is rather wonderful, by the way, how well workmen used to rendering such a very different type of work have succeeded in translating this more broken and much less flat kind of design into tapestry.

If the ideal tapestry must be, as some people believe, of necessity all in one plane, with no perspective save the simplest, and with little or no attempt at modelling, this new piece cannot be said to be quite perfectly adapted to its purpose; but that is a standard which would by no means be universally admitted, and, whichever view we may happen to hold, we are bound to confess that in "The Chace" we have a piece of tapestry which is very pleasant to look upon.

The name of the firm of Morris and Co. is sufficient guarantee that the tapestries produced by them will not be mere pictures translated into wool—without any particular decorative feeling; that they should be a little more or a little less on the pictorial side will appear good or ill according to the personal bias of the critic. At any rate, the fact that a new tapestry is in contemplation, if not actually in the loom, after a design by Mr. Byam Shaw, is sufficient indication of the decorative lines on which they mean to follow up their new departure. The work of both Mr. Heywood Sumner and Mr. Byam Shaw is, of course, pre-eminently decorative, but it is very different in style and character, and it will be very interesting to see which lends itself most readily and easily to tapestry design. Probably the results will be so different that it will be difficult, if not impossible, really to compare them.

The Student and his Public.—The various art and technical schools all over the country are day by day turning out students who are at least by way of being proficient in one or more of the artistic crafts. It is often difficult to see what is to become of these students. They are not as a rule trained as the ordinary workman, nor would they always take a workman's place if it were offered to them. They pride themselves on being craftsmen and craftswomen, and look down with easily-understood pride upon producers of "trady" work. It seems sometimes as though they had, and could have, very little influence upon the trade of the country. Their wares are not sold in the ordinary shops. As a rule they dispose of them themselves through private recommendation or take orders for them at various little exhibitions got up on the lines of glorified bazaars —often at prices which are at least suggestive of sweating. There is, in short, a great deal of energy wasted because the craftsmen and the public do not get into touch with each other—and the societies formed to help matters have not been strikingly successful. There remains another solution of the difficulty,—for the schools to get into direct contact with the purchasing public. This has been done by some schools in a modest way, and with quite a fair measure of success—it has been attempted by others on lines which have only brought discredit on the work of the school.

The Sir John Cass Arts and Crafts Society.—The idea of bringing the work o competent students who have finished their training before the public by means of small exhibitions held outside the school, is the way that has commended itself to some of those in authority at the Sir John Cass Institute. The Arts and Crafts Society, calling itself after the name of that institution, and made up of ex-students and teachers, has for the last three years held an annual exhibition of members' work. The fact that the first show was held at a private house, and the second at a gallery at Notting-hill-gate, whilst the third is in Bond-street, is indicative of some measure of success on their part. The exhibits this year, apart from some excellent little water-colour sketches by Mr. G. E. Kruger, and some very rude pottery by Mr. Wells, consist entirely of metal work; and it is seldom that one sees so much good work at one time. Mr. Stabler's work is too well known to need praise; it is only necessary to say that what he shows at Walker's gallery is up to his usual level. Mrs. Hart Partridge's miniatures in translucent enamel are, both in taste and execution, far above the average; whilst the jewellery, which forms the bulk of the exhibition, is almost always satisfactory. The work of Miss Violet Ramsay and Miss C. M. Kirkman may be mentioned as particularly good, but the exhibits as a whole are a great deal better than the ordinary run of such things, and show a restraint, a taste, a sense of design and of colour which it is very refreshing to see. When such good jewellery as this is to be had at the very reasonable prices asked by the exhibitors, there seems no excuse for wearing, or at any rate buying, what is bad.

GENERAL NOTES.

British Trade with Bolivia.—Reporting on the trade of Bolivia, the Hon. Henry Dundas, His Majesty's Consul at La Paz, says (Annual Series, No. 4128) there are many lines which offer a very profitable field for the enterprise of British manufacturers in articles not known in Bolivia, and in works and constructions for developing industries which would create a large demand for certain manufactured articles. But in these matters the native mind requires to be enlightened; some technical guidance is necessary, with some knowledge of mechanics, hydraulics, and engineering, to show what can be done with contrivances which in other countries help to increase the value and output of natural resources. As instances of what foreign enterprise is doing in this respect, the Consul mentions the case of a German firm of electrical engineers, who, with an outlay of about £30,000, are drawing 550 horse-power of electric energy for industrial purposes from a stream that runs some six or seven miles from Sucre. This is expected to create a large demand for electrically-driven machinery and electric light appliances; but the same firm has the monopoly of all such importations, coupled with a contract for public lighting. In Potosi a Swiss engineer has installed a similar concern on a much larger scale, which shows the way to overcome many of the obstacles which hampered the mining industry in that district.

The Duration and Direction of Large Earthquakes.—In a paper communicated to the Geological Section of the British Association, Dr. John Milne states that "Small earthquakes, as for example those which occur in this country, have a duration of a few seconds near to their origin. At places 50 or 100 miles distant they may not be recordable. The duration, therefore, has varied between a few seconds and zero. With many large earthquakes, however, this decay during transmission is not appreciable, and duration near to their antipodes may be as great as it is near to their origin. Duration, as these disturbances travel, at times appears to increase rather than decrease. The greatest duration is at about 90° distance from an origin. That which occurs may be compared with what we observe after a flask of water has been tilted. The contents oscillate like a pendulum, and any one part of the fluid comes to rest about the same time as any other part. Another observation in connection with recent seismological observations is that large earthquakes travel farthest in particular directions. I have taken seventy-nine large disturbances with fairly well-known origins south of the Caucasus, north of India, and to the east or south of Japan. These earthquakes have travelled farther to the west than to the east, and there has only been a small percentage of them that have found their way across the equator, to observatories in the southern hemisphere.

Cotton in Egypt.—In his report on the consular district of Alexandria (Annual Series, No. 4127) Mr. Acting Vice-Consul Grieg says that, realising the position of cotton and the marked deterioration in the yield and quality, the Government has called in the best scientific assistance available, and has appointed a commission to investigate fully the causes of the deterioration of the cotton crop. The leading expert on cotton, Mr. F. Fletcher, has been appointed Principal of the Agricultural College, and is continuing his experimental research on the "Toxic Excreta from Plants and Crop Rotation." This research will explain fully the fertilising effect of the "red water" of the Nile flood, which has never yet received a rational explanation. The Khedivial Agricultural Society has examined the life history of several insects and pests which attack the cotton plant, and has suggested preventive measures. In December last, a capital expenditure of £2,000 E. was granted by the society to found an experiment station for the study of Mendelism in cotton. This work is in the hands of Mr. W. L. Balls, who has already found it possible, by applying Mendel's law of heredity to synthesise by cross fertilisation new kinds of cotton with desirable qualities. The high price of cotton still induces cultivators to devote their land to it in preference to sugar or wheat; but the unwisdom of relying so much on one crop has been frequently pointed out, and by no one more cogently than by Lord Cromer in his report for 1905.

MEETINGS FOR THE ENSUING WEEK.

Monday, Nov. 23...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. O. Guttmann, "Twenty Years Progress in Explosives." (Lecture I.)

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. H. T. Scoble, "The Administrative Aspects of Sewage Disposal."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. J. W. Jenkinson, "Sea Urchins, and the Relation between the Individual and its Environment."

Tuesday, Nov. 24...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. D. A. Matheson's paper, "Glasgow Central Station Extension."

Photographic, 66, Russell-square, W.C., 8 p.m. Mr. W. Bickerton, "Wild Birds and their Ways."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 4½ p.m. Mr. J. Alldridge, "Sierra Leone Up-to-Date."

Horticultural, Vincent-square, Westminster, S.W., 3 p.m.

Wednesday, Nov. 25...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Sir Martin Conway, "The Goldfields of Eastern Peru and Bolivia."

Auctioneers, 34, Russell-square, W.C., 7½ p.m. (Junior Section.) Mr. C. A. Young, "Bogus Auctions."

Thursday, Nov. 26...London Institution, Finsbury-circus, E.C., 6 p.m. Mr. C. W. Saleeby, "Evolution: Fifty Years After."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Mr. W. R. Cooper, "Domestic Electricity Supply (including Heating and Cooking) as affected by Tariffs."

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FRIDAY, NOVEMBER 27, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, NOVEMBER 30, 8 p.m. (Cantor Lecture.) OSCAR GUTTMANN, M.Inst.C.E., F.I.C., F.C.S., "Twenty Years Progress in Explosives." (Lecture II.)

WEDNESDAY, DECEMBER 2, 8 p.m. (Ordinary Meeting.) ERIC STUART BRUCE, M.A., "Mechanical Flight."

Further details of the Society's meetings will be found at the end of this number.

H.M. THE KING OF SWEDEN.

The Council of the Society having elected H.M. the King of Sweden an Honorary Royal Member, H.R.H. the Prince of Wales, as President of the Society, graciously communicated to King Gustaf the fact of his election, and has now received from His Majesty the following letter of acceptance :—

WINDSOR CASTLE,
November 19th, 1908.

SIR,

I will be most gratified to accept the honorary Royal membership of the Royal Society of Arts of which your Royal Highness is the distinguished President.

The fact that my lamented and beloved Father was for so many years connected with that illustrious Society makes the honour conferred upon me still more appreciated.

I have the honour to be,
Sir,
Your Royal Highness's
Very sincerely,
GUSTAF, R.

His Royal Highness
The Prince of Wales,
President of the Royal Society of Arts.

COUNCIL.

At their meeting on Monday last, the 23rd inst., the Council elected Sir William H. Preece, K.C.B., F.R.S., to fill the vacancy caused by the lamented death of Sir Charles Malcolm Kennedy, K.C.M.G., C.B.

RETIREMENT OF MR. H. B. WHEATLEY.

At their meeting on Monday, the 23rd inst., the Council passed the following resolution :—"That the Council desire to record their appeciation of the long and faithful services which Mr. H. B. Wheatley has rendered the Society since the year 1879, and to express their hope that he may yet have before him many years in which to continue in his retirement the useful historical researches with which his name has been so long associated."

SECTION OF APPLIED ART.

The Council have decided to merge the work of the Applied Art Section in the general work of the Society, so that papers dealing with applications of art to industry will in future form part of the list of the ordinary Wednesday evening meetings, instead of being read in a special section.

CANTOR LECTURES.

On Monday evening, 23rd inst., Mr. OSCAR GUTTMANN delivered the first lecture of his course on "Twenty Years Progress in Explosives."

The lectures will be published in the *Journal* during the Christmas recess.

MEDAL TO PROFESSOR GALLOWAY.*

At the first Ordinary Meeting on Wednesday evening, 18th inst., Sir William White, the Chairman of the Council, presented the gold medal awarded under the Shaw Trust for Industrial Hygiene to Professor Galloway, "In recognition of his valuable researches into the action of coal dust in colliery explosions, the outcome of which researches has been the provision of means by which the risk of such accident is materially diminished, and a consequent great saving of human life effected."

SWINEY PRIZE.

The Council have to give notice that the next award of the Swiney prize will be in January, 1909, the sixty-fifth anniversary of the testator's death. Dr. Swiney died in 1844, and in his will he left the sum of £5,000 Consols to the Society of Arts, for the purpose of presenting a prize, every fifth anniversary of the testator's death, to the author of the best published work on Jurisprudence. The prize is a cup, value £100, and money to the same amount; the award is made jointly by the Royal Society of Arts and the Royal College of Physicians. The cup now given is made after a design specially prepared in 1849 for the first award, by D. Maclise, R.A.

In accordance with the arrangement with the Royal College of Physicians, the award next year will be for Medical Jurisprudence.

Any person desiring to submit a work in competition, or to recommend any work for the consideration of the judges, should do so by letter, addressed to the Secretary of the Society.

The following is the list of the recipients :—

1849. J. A. Paris, M.D., and J. Fonblanque, for their work, "Medical Jurisprudence."

1854. Leone Levi, for his work, "The Commercial Law of the World."

1859. Dr. Alfred Swayne Taylor, F.R.S., for his work, "Medical Jurisprudence."

1864. Henry Sumner Maine (afterwards K.C.B.), D.C.L., Member of the Legislative Council of India, for his work, "Ancient Law."

1869. William Augustus Guy, M.D., for his "Principles of Forensic Medicine."

1874. The Right Hon. Sir Robert Joseph Phillimore, D.C.L., for his "Commentaries on International Law."

1879. Dr. Norman Chevers, for his "Manual of Medical Jurisprudence of India."

1884. Sheldon Amos, M.A., for his work, "A Systematic View of the Science of Jurisprudence."

1889. Dr. Charles Meymott Tidy, F.C.S., for his work, "Legal Medicine."

1894. Thomas Erskine Holland, D.C.L., for his work, "The Elements of Jurisprudence."

1899. Dr. J. Dixon Mann, F.R.C.P., for his work, "Forensic Medicine and Toxicology."

1904. Sir Frederick Pollock, Bart., and Professor F. W. Maitland, for their book on "The History of English Law before Edward the First."

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1s. 6d. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

SECOND ORDINARY MEETING.

Wednesday, November 25, 1908; Sir Henry Trueman Wood, M.A., Secretary of the Society, in the chair.

The following candidates were proposed for election as members of the Society :—

Bain, John Anderson, The Vacuum Oil Company, York-house, Norfolk-street, Strand, W.C.

Barbour, John Milne, M.A., J.P., Conway, Dunmurray, Co. Antrim, Ireland.

Greenway, Charles, Stratton Chase, Chalfont St. Giles, Bucks.

Hart, George, 28, Wardour-street, W.

Low, Charles Watson, 23, Wellington-court, Knightsbridge, W.

Murray, John, F.R.I.B.A., 11, Suffolk-street, Pall-mall, S.W.

Sheppard, V. L. Osborne, Survey Department, Kafr el Zayat, Egypt.

Wood, Mrs. W. Martin, Underwood, Oatlands-avenue, Weybridge, Surrey.

Wylie, John Howie, Agates, Herstmonceux, Hailsham, Sussex.

The Chairman, before calling on Sir Martin Conway to read his paper, expressed his regret, which he was sure the audience would share with him, that Sir Marcus Samuel, who was to have presided over the meeting, had been called away to the continent.

The paper read was—

* By an unfortunate oversight this announcement was omitted from the *Journal* of last week.

THE GOLDFIELDS OF EASTERN PERU AND BOLIVIA.

By Sir W. Martin Conway, M.A., F.S.A., F.R.G.S.

Throughout the whole long north-west and south-east extension of Peru and Bolivia, the main determining geographical feature on which all the others depend, is the long double Cordillera of the Andes. On one side of them lies the Pacific Ocean, on the other the low large basin of the Amazon. To both ocean and plain the mountains fall rapidly, the elevated region between them being seldom more than 400 miles wide. Between the two Cordilleras there lies a high plateau, long and narrow, containing in the latitude with which we shall be concerned the great lake Titicaca, at an altitude of upwards of 12,000 feet above the sea-level—itself a mere shrunken remnant of what was once a very much longer lake that stretched far down into Chile. The regions on either side of the Cordilleras differ in character in almost every respect, but in none more than in their climate. The western, or Pacific slope, is barren and practically rainless, cut across by rivers few in number and insignificant in volume. The eastern, or Amazon slope, is one of the most fertile regions in the world, constantly haunted by a roof of cloud and subject to a rainy season (in our winter months) during which precipitation takes place in a most emphatic manner. Of this rainy season I shall have more to say presently. The plateau region is high and rather dry. The fringe of the rains reaches it, but they do not deluge it. Here were the great centres of the ancient population, and here to the present day a vigorous Indian population still maintains itself. Cuzco and La Paz are high plateau cities, the latter being the capital of Bolivia and an increasingly busy home of industry and centre of trade.

If the fertile region had happened to occupy the western instead of the eastern slope it would have been famous amongst the most fertile regions of the earth, for by some strange combination of circumstances it seems to possess the faculty of producing almost in perfection every kind of vegetable product that it grows. Nowhere do trees attain greater perfection of form, nowhere are fruits more luscious, nowhere is sugar more bountiful, nowhere is coffee produced with greater perfection of flavour. Moreover, the climate is delightful and very healthy, and the whole region, down to a level of about 2,000 feet above sea, is perfectly adapted to be the home of white men. This earthly paradise, however, is not situated on the Pacific but on the Amazon slope, and so can only be reached for practical purposes by passing over both the Cordilleras. A traveller from Europe or the United States who desires to visit the Peruvian provinces of Sandia and Carabaya, or the Bolivian provinces of Larecaja, Caupolican and Yungas—which approximately contain the area I am now referring to—must first voyage down the Pacific from Panama to the Peruvian port of Mollendo. Landing there he will find a remarkable railroad, by which he will ascend through the important city of Arequipa to the crest of the outer or western Cordillera, which he will reach at a height of some 14,500 feet. Thence the train will run him down to the borders of Lake Titicaca, at the port of Puno. Being now on the floor of the plateau two main routes are open to him. He can either go northwards towards the terminus of Cuzco, or southwards by steamboat down the lake to its southern port Guachi, where another railway awaits him to carry him onwards in a southern direction. If he takes the northern route, he can quit the train at several stations, from which trails, more or less well-made, will lead him to different passes over the inner or eastern Cordillera, the famous Cordillera real. These trails will carry him down to different parts of the fertile eastern region. If he takes the southern route down the lake, and on by the Bolivian railroad, he will presently reach the capital, La Paz. Beyond that, he will ultimately come to Oruro, further on to Vyuni, and ultimately, after some four days in the train, he will find himself far south on the shore of the Pacific again, at the port of Antofagasta. It is only during the first part of this southern route that he will find opportunities of quitting the train and striking away eastwards to high passes, and over them, down to the region we are concerned with to-day.

Of these various eastward routes, I have only time now to refer to two. The first is the road and trail that quits the Cuzco railroad at the station of Santa Rosa, and, after traversing a pass in the Cordillera real, leads down to the valley of the Inambari; the second starts from the city of La Paz, and, after passing over the mountains, gives access to the valley of the river Beni.

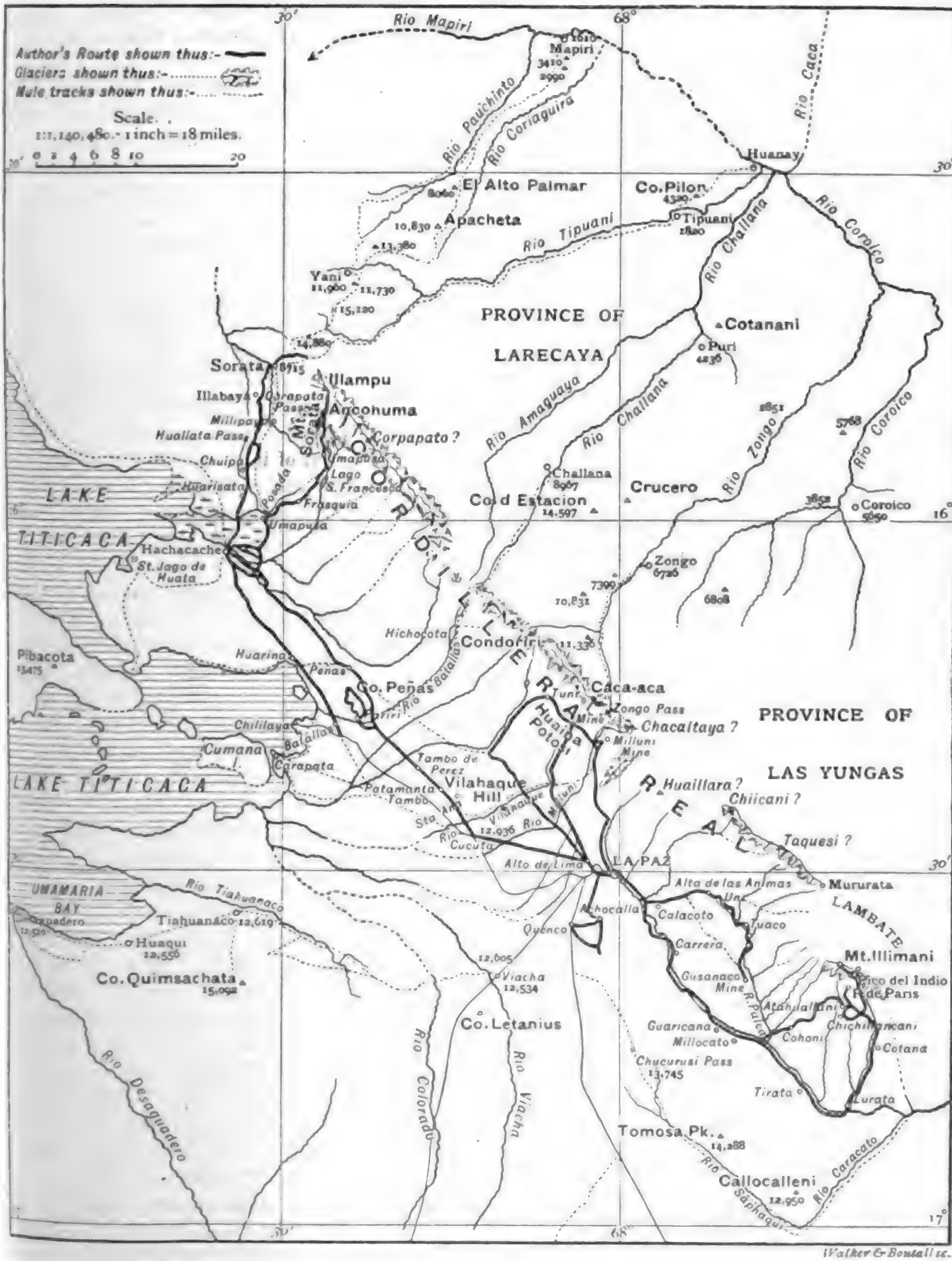
But first let me say a word about these two

rivers, the Inambari and the Beni. If you follow them down you will see that the Inambari runs into the Madre di Dios, and that ultimately the Madre di Dios and the Beni unite and join the Madera not far above the 120 miles of rapids and cataracts which prevent that noble river from being navigable right up from where it joins the Amazon in the neighbourhood of Manaos. If, however, instead of following these rivers downwards you follow them upwards, you will find that each of them subdivides into a number of tributaries arranged like the ribs of an open fan; and if you follow these tributaries upward, you will find them one after another taking their rise on the eastern side of the Cordillera. The extreme northern tributary of the Beni, and the extreme southern tributary of the Inambari (of those tributaries that spring from the Corderilla) take their rise quite close to one another, the intervening Tambopata river only separating their sources by a single tiny thread of water, so that we may say that, for a distance from north to south of some 120 miles at least, all the drainage of the eastern slope of the Corderilla real—every snow flake that falls east of its crest, and every drop of rain that descends on its eastern face, finds its way by one tributary or another either into the Beni or into the Inambari rivers.

It follows that these two river valleys are destined to be two of the great highways of the future, and the passes and roads that give access to them from the high plateau must be the most important land routes in this region. Ultimately, the trails that now give access to those two rivers must be made travelable down to the head of navigation in each case. The head of navigation on the Inambari is where the Chaspa river joins it, and a mule road is now almost carried to that point. The head of navigation on the Beni is at a place called, or to be called, Puerto Pando, and a road is being made to that spot, and is already carried down to the point where raft navigation is established. The Inambari road goes through a place called Ollachea; the Beni road at present ends at a place called Caranavi, so that they may be named respectively, the Ollachea and Caranavi roads, and I shall in future so refer to them. At present, they are good mule-tracks. Before many years have passed they will, almost certainly, be replaced by mountain railroads. When that has been accomplished, the development of the regions they serve will be of a character to attract the attention of the world, for the fertility of the land there is almost beyond belief. At present, the roads exist, or are being made, primarily in the interests of collectors of india-rubber, because rubber is the only product of the land sufficiently precious to pay for the cost of transport through so difficult a country. All the tributaries of the Inambari and Beni rivers, below the level of some 2,000 feet above sea, traverse forests excessively rich in *Hevea brasiliensis* and other rubber-producing trees. These forests as yet can hardly be said to be exploited. Only the edges of them are attacked, and the rubber that comes from them is a mere trifle compared with what they could produce if a large enough staff of labourers could be put upon the ground. It is possible that the inevitable development of the gold industry, to which I am now going to invite your attention, may have the effect of attracting population rapidly to this region. Gold has brought people wherever it has been found in quantity, and the population which came to mine has generally remained to pursue agriculture. For this reason, if for no other, the Peruvian and Bolivian Governments should foster the gold-mining industry as much as possible, for it is population that both countries need, and nothing brings population together more rapidly than does a rush for gold.

At the present day Peru and Bolivia are great mineral-producing countries. They export silver, copper, and tin. Bolivia is now second in rank among the tin-producing countries in the world. It likewise contains a copper region richer even than that on the banks of Lake Superior, which is famous throughout the world. As for its silver, who has not heard of the mines of Potosi? Antimony, bismuth, and all kinds of other mineral wealth come from this remarkable region. Yet, when the Spaniards first came in contact with the Incas it was not their wealth in these metals that astounded them, but the marvellous quantity of gold they possessed. Never before in the history of the world has so much gold been seen together at once as the great hoard of the Incas. It was this that drove Pizarro and his companions almost frantic. Yet to-day Peru and Bolivia do not produce gold to any very great quantity. It was this strange discrepancy that first called my attention to the question of Bolivian and Peruvian gold.

During my exploration of the snowy region



THE CORDILLERA REAL AND ADJACENT COUNTRY OF BOLIVIA.

of the Cordillera real and its high passes in the years 1898 and 1900 I more than once came across or heard of points in the region of perpetual snow where veins of gold-bearing quartz were exposed. These were always in positions of practical inaccesibility, so far as any possible working is concerned. The existence, however, of gold at high levels in any glaciated region is always worth notice, because alternate frost and heat at high levels is the finest crushing machinery in the world, whilst there is no better transporting and pulverising agent than a glacier. I arrived at the conclusion that somewhere, at a very high level on the eastern face of the snowy range, a considerable body of gold ore exists, and a much larger body formerly existed. This conclusion was confirmed when I discovered that all four of the principal tributaries of the upper Beni or Kaka river bring down gold in their gravels. These rivers, in order from south to north, are the Coroico, the Challana, the Tipuani, and the Mapiri. On each and every one of them the natives are accustomed to wash gold out the gravels at numerous points, and they set up riffles at certain places before the rainy season to entrap the gold that is brought down by the floods year after year. I need not delay to tell you in detail all that I learned about these different streams and the gold washing on them, because it would be nothing but a repetition over and over again of the same tale. The Tipuani may be taken as typical of all of them. This river takes its rise at the crest of the Cordillera, and near its head waters is situated a place called Yani. In the mountain side strong veins of gold-bearing quartz have long been known, and they have been and still are intermittently worked by the natives in the simplest fashion, the ore being hacked out where it looked most promising, fragment by fragment, broken up by rolling a boulder about on it, and the product washed by hand. What kind of extension this source of gold may have in the high cliffs and recesses of the mountains at the head of the Tipuani Valley is not known; but what is known and has been known ever since the days of Pizarro, is that all the way down that river you can get some gold out of almost every pan of gravel you like to wash. I need not pause to describe in detail the richness of the Tipuani gravels, because they have been examined and reported on again and again, though practically nothing much remained to be added to the published reports of Weddell.* His visit to this region was made about the middle of the nineteenth century. He was a fully equipped expert, and he published his observations in a volume which remains the classical account of the Tipuani gravels.

I afterwards learned that what is true of the tributaries of the Upper Beni is likewise true of the tributaries of the Upper Inambari, a larger number of which have been prospected. Thus 21 rivers, large and small, flowing into the Inambari have been found to bring down gold, and 15 of them are regularly frequented by Indian gold-washers.

We have thus proof that the eastern slope of the Cordillera real for over 100 miles of its length yields gold in all its river gravels, and this gold must originally have come from the heart of the range itself. Somewhere, probably high aloft, countless ages ago, there existed (and the remnant of it doubtless still exists) a great deposit of gold. This has been broken up by the frosts of winter and the night; has fallen on to the glaciers and been carried down by them; has been liberated from the embrace of its matrix by being ground up and pounded in and under the ice or smashed in avalanches; it has been tumbled into the raging torrents of the high valleys; the separated gold has been swept down, and is still being swept down, by the streams, and has been, and still is being, deposited at suitable places in the lower levels, where the force of the water no longer suffices to transport it. For countless ages this process has been going on, and for countless ages the separation and accumulation have been taking place.

It was no doubt from these upper tributaries of the Beni and the Inambari that the Incas obtained their vast supply of the precious metal. Tradition asserts it. There are plenty of signs of ancient operations. The modern Indian believes himself still to be continuing the old habits of his ancestors when he descends to these valleys to pan for gold.

You will doubtless then enquire, as I did, why, if gold exists in payable quantities for the most rudimentary system of working, at a countless number of known points over so large an area—why has it never been worked on a large scale, and with the assistance of modern methods of extraction? The answer

* H. A. Weddell: Voyage dans le Nord de la Bolivie et dans les parties voisines du Pérou, ou Visite au District aurifère de Tipuani. Paris, 1853.

is a very simple one. I have already spoken of the difficulty of access to these regions even now, when railways have been carried from the sea to the high plateau over the outer Cordillera. Those difficulties are great, but they are not insurmountable, and they would long ago have been surmounted if that was the only trouble to be faced. Nature, however, has imposed far more serious impediments than mere difficulty of access in the way of those who would extract gold from the gravels of these upper tributaries. The determining obstacle is the rainy season. Bear in mind that the crest of the Cordillera rises to altitudes of from 21,000 to 22,000 feet, and that its passes seldom sink much below 16,000 feet. You see what a mighty wall Nature has to deal with, and you can easily conceive how mightily it has to be buttressed. The buttressing of this mass to the eastward, is effected by rows of foot-hills, successively diminishing in altitude. In forty miles from the crest of the Cordillera, as the crow flies, you will have already descended to a level of only about 2,000 feet above the sea. Another forty miles brings you almost to the edge of the Amazon plain, which, at its western extremity, is only some 500 feet above its eastern Atlantic lip, about 3,000 miles away. Thus you will observe that, not only does the ground fall away with great abruptness from the crest of the Cordillera, but that the torrents, which descend the slope, are carried through a most tortuous country, where every kind of impediment obstructs their course. Now on to this labyrinth of steep valleys, at certain seasons of the year, the heavens pour a deluge of rain. Tropical downpours of enormous volume succeed one another, day after day, during the wet months. It is not a steady rain, that endures all day, but a series of sudden and violent discharges which fling themselves here and there upon the mountain sides, and have to be carried away under the irresistible impulse of gravitation. What is the obvious result? The rivers in this involved region rise in sudden and overwhelming floods, now this river, now that, according to the direction of the centre of the day's downpour. The valleys are narrow, steep, and encumbered with huge boulders. The torrents therefore come down in sudden spates, the level of the waters sometimes rising as much as 50 feet in the course of two or three hours. Of course such floods excavate the banks, which fall into the trough and sometimes form temporary dams; these pile up the water behind them till it bursts the obstruction and rushes down with increased violence. At the same time the saturated hill sides are under strain; they give way here and there, and enormous landslips are produced. Mud avalanches too are formed, and violently scour the gullies—in fact there is no place that may not give way, no platform that is absolutely safe. It follows that the installation of machinery in such a region is impossible. People who have not seen a rainy season, nor had elsewhere the experience enabling them to imagine it, have tried to set up hydraulicking apparatus, canals along the hill sides for sluicing, and what not. They have always failed. Nature will not tolerate the permanent settlement of human contrivances in these regions, where the face of the earth is in the making. Here her sculpturing hand is busy, and what man sets up she is at any moment liable to rub away. Even lower down, where the worst of this turmoil is over, it is dangerous to attempt serious operations. One company set up a dredger at great expense on a stretch of river in an upper reach of the Inambari. It was unable to get to work. There was plenty of gold about, but there were likewise plenty of boulders. The machine could not work. The only thing to do was to lower it further down the river. An attempt was made. Rapid after rapid had to be descended. Now the waters rose and now they shrank. At last, when the dredger was nearing easier places, she was moored for the night. Before anyone could realise what was happening the waters sank nine feet, and the dredger was deposited on the point of a sharp rock, which penetrated her hull, and wrecked her.

Thus effort after effort has been made to win gold out of these many and rich Andes torrents, but no one has been successful since the Incas. How is it that they succeeded where all modern effort has failed? The answer is that they were able to employ forced labour. They got their gold by hand-panning. All the treasure of the Incas was so obtained, pan by pan. Year after year, generation after generation, the hoard went on piling up. There were no labour-saving appliances worth modern consideration. At some places, such as Aporoma, perhaps (which I have not seen), they may have been able to lead a stream along an artificial canal to a point where sluicing was possible. In a general way that could not be done, and most of the spots pointed out by tradition as the places where great quantities of gold were obtained are so situated and

constituted that only hand-panning can be done at any of them.

Let me now once again remind you that the transportation of gold from aloft, which I have described, has gone on for countless ages—a time geologically short, but infinitely long in comparison with the lives and memory of men. During all that time the gold has been deposited somewhere in beds of denuded and transported material. The Andes have been piling their own *débris* about their feet since first the Cordilleras began to rise out of the level plain. These *débris* in process of time have hardened into slates and conglomerates with the gold distributed throughout them, and these slates and conglomerates have been bent and elevated into foot hills by earth movements. Through and along these foot hills still course the successors of the very streams that brought down the materials of which they are built up. These streams are now actively engaged in cutting down the foothills themselves. No sooner does any elevation rise above the normal level than Nature provides an agency to cut it down. It may go up faster than the denuding agency can cope with—in that case the elevation continues to rise—but none the less the denuding action takes place, and some disintegration is accomplished. The foothills of the Bolivian part of the Cordillera were discovered by Dr. Evans to contain gold in their slates and conglomerates. To the gold brought down from the high levels is added the gold washed out from these more recent formations. Dr. Evans observed on the Kaka river that those gravels were richest in gold which were found just below a gorge in the foothills. In fact at such points the gold had undergone a second concentration—sometimes perhaps even a third. It follows that the best sites for gold washing are not necessarily those nearest to the source of first supply, but may be found considerably lower down. The gold in the Cordillera itself no doubt comes out of silurian rocks, with talcose and clay slates and many intrusions of granite rocks and many quartz veins. But it is not directly from the quartz veins that all the gold comes that is washed in the torrents. Originally quartz-veins yielded it, but it has had a long subsequent history in the sedimentary formations in which it has rested. That this is the case is shown by the character of the gold which the washers bring in. It almost invariably consists of flattened particles like fat little grains of gold which have been submitted to pressure since they were freed from their original lode. They are not flakes, but in shape like tiny magnifying glasses, thicker in the middle than at the sides, and often as large as, sometimes much larger than, the head of a pin. I have seen plenty of fragments as large as the section of a hempseed, but, of course, the average fragment is very small. Whether small or large, however, it is usually flat, and appears to have undergone pressure.

I will now come to the important discovery to which my own observations and conclusions contributed somewhat. When I had made myself thoroughly acquainted with the geography of the tributaries of the Kaka, or upper Beni river, and had realised that every one of them was carrying down gold, and that this gold could not be won, mainly because of the overwhelming rush of the waters; and when I had learned that the four great tributaries I have mentioned unite together, still within what I may call the torrential zone, and that after uniting near a place called Guanay they enter a gorge which is not wide enough for any considerable deposit of gravels to take place along its banks; it occurred to me that if anyone would descend this gorge—as can easily be done on a raft such as the natives of those parts are accustomed to navigate—he would be likely to find somewhere below the gorge, wherever the steep banks first receded, some extensive deposit of gravel which would be likely to be rich in gold. I argued that at that level, below the rapids and where the river was wide enough to accommodate the flood waters from above, the gold alluvials, if found, could be safely and easily worked.

It was then too late for me to pursue the investigation myself, but I shared my conclusions with Dr. George Bridgman, at that time American Minister to Bolivia, and my most kindly host. We talked the matter over together, and he agreed to look out for a suitable expert and send him down to see whether there was any truth in my conclusions. That was in the year 1898. It was eighteen months before he could find the man he wanted, and then he came across an experienced American gold prospector, who had panned gold anywhere and everywhere between Klondyke and the Straits of Magellan—if there was any truth in the wonderful stories he told. Anyhow, down he went. He passed through the long gorge below Guanay, and below it he came out into an old lake basin filled to the brim with gravel in the process of ages. There he landed on the bank, and proceeded to wash a pan of gravel. To his astonishment it yielded gold at

the rate of 17s. 6d. per cubic yard. He washed another, and another, and another, and always with astonishing results. He had never seen the like in all the years of his wanderings, and he hastened back to La Paz, in a wild state of excitement, of which I was witness when I chanced to arrive there a few days after he had come in. That was how gold came to be discovered on the lower and quieter reaches of the Kaka (Beni) river. No one had ever thought of looking for it so far down; the possibility of a second concentration had not occurred to them.

Of course, our knowledge of the facts does not rest upon this first discovery. Since then expedition after expedition has gone down, and the ground has been examined almost yard by yard over the areas that are now in the possession of different owners. Of these expeditions the most important from a scientific point of view was that conducted by Dr. John Evans, formerly mining adviser to the Government of Mysore, and now geologist to the Imperial Institute. His expedition was in every sense a scientific one, and the results of it were described in a paper read before the Royal Geographical Society. At that time difficulty of access was the great impediment. The only way to go from the Bolivian plateau was by an exceedingly circuitous and difficult route. The Cordillera had to be crossed at an awkward point, where it bifurcates, so that two passes of over 15,000 feet had to be traversed and a descent made between them to the town of Sorata, which is, I believe, not much more than 8,000 feet above sea. Beyond the second pass it was necessary to descend either the difficult and pestilential Tipuani valley or to go over the hills to the Mapiri river and float down its rapids. In either case Guanay was reached and the descent continued down the Kaka river by raft. Since then a new road has been made from La Paz to the kinder waters of the Coroico. This is a good mule road over which machinery can be, and has been, carried. The remainder of the way has to be accomplished by raft, but I understand that the Government intends to carry the road itself down to the Incahuara dredging ground (as the lake basin I have mentioned is called) during the course of the coming year.

What is true of the Kaka river in respect of its auriferous gravels and the low level to which they extend is likewise true of the neighbouring Inambari river. There, as I have said, the upper tributaries were known to be rich in gold, but no one thought even of prospecting on the lower reaches. So true was this, that the first gold mining concession granted by Peru for working the gold alluvials of the Inambari—a very large one intended to embrace all the valuable ground—only covered so much of the upper part of the river as is practically included in what I call the torrential district. The lower and far richer region, and the only region where gold dredging can be easily and (in the first instance, at any rate) safely attempted was not within the area of the concession. Here again, however, later exploration showed the true situation of affairs. It was the india-rubber men this time who discovered the gold. The banks of the Inambari, down to its junction with the Madre di Dios, are covered with forest in which india-rubber trees abound. This forest has been the subject of various concessions, and different companies—one of them English—are now occupied in the attempt to get the rubber out. In connection with the rubber work a road had to be made down to and along the lower course of the Inambari river as far as the head of navigation. The rubber people, occupied with this road, discovered that natives were in the habit of visiting this part of the river for the purpose of washing gold. They also found that their rubber pickers were inclined to spend more time in gold washing than in rubber collection, as being the more profitable occupation. Thus prompted, the English managers made experimental washings themselves, and obtained surprising results. They called for professional assistance and made a rapid examination of a long stretch of the river bank, and wherever they washed a pan of gravel they obtained some gold, and in many places they found it in great quantities. A more elaborately organised expedition was sent out from home, and more ground was examined with a like result. The gold obtained from the Inambari entirely resembles in form and quality the gold obtained from the Kaka; in both cases it is flat and relatively thick, and has evidently been subjected to pressure after leaving its original vein.

Alike at the Incahuara basin on the Kaka (Beni), and on the banks of the Inambari, when a pan of gravel is washed, the heavy residue containing the gold is a black sand. The analysis of a sample of this sand, from which the gold has not been separated, is as follows:—

	Per cent.
Silica	8·50
Gold	0·27*
Silver	0·024†
Copper	0·55
Arsenic	0·50
Iron	37·10
Alumina	24·30
Titanic oxide	4·18
Manganese	1·50
Sulphur	1·57
Oxygen (by difference)	21·406
	100·00

* = 88·20 ozs. per ton.
† = 7·84 " "

This sample came from the lower Inambari. The Kaka black sand is similar.

It must be observed that thus far all that is known about the Incahuara and Inambari gravels is the result of exploratory expeditions. Companies have been formed, and are proceeding to test these gravels by actual working, and their results will be watched with interest. All that the various experts, who have spent time examining the ground, have been able to do was to ascertain surface values. At Incahuara, however, many pits were dug, and the ground was explored to a depth of 16 feet, and found to remain equally rich all the way down. At no place has bed-rock been reached, because the water always poured in when the level of the river was reached and put a stop to downward progress. Neither has the bed of either river been examined. It is only possible to ascertain values below water-level by actual working.

Only one method of working these gravels is practicable and that is by dredging. The ground does not fall steeply enough for sluicing or hydraulicking, but for dredging it is excellently adapted. To begin with, at Incahuara for instance, there are no boulders at all, the largest stones being little bigger than a man's head. Most of the reaches of the lower Inambari (except where torrential side streams enter it) are void of boulders. On neither river, again, is there any hard clay, but the ground is loose—a mere compound of stones and sand. Again, at Incahuara, the bed-rock is of friable nature, easily scraped by the lip of the dredge-buckets, and a similar bed-rock appears to be common on the Inambari. The current of neither river at the points of interest to the gold-dredger is swift enough to cause any danger to the vessel. In flood time it can float over and excavate the banks, or can be worked in a paddock. During low river it can delve up the bed of the stream. Of course, the transport of dredgers to these remote places is difficult and costly—that is a matter for shareholders to consider and does not concern us—but in the case of the Incahuara dredger it is partly accomplished, as a considerable part of the machine is said to have been already transported to the site. The Ollachea road presents no greater difficulties than does the Caranavi according to the statements of travellers.

In conclusion, the important question that has to be answered is this, What is the extent of these two dredging grounds? and are they likely to afford a notable increase in the world's supply of gold, or are they merely small areas, rich perhaps as far as they extend, but of only moderate extension? The answer to this question can only be very hypothetical. The only part of the ground, along the banks of either the Inambari or the Beni river, that has been examined elaborately by competent men, is the Incahuara basin. That contains at least 1,000 hectarias of dredgable gravels, averaging, it is supposed, about ten yards in depth, or containing ten million cubic yards of gravel. Its surface has been sampled all over, and has nowhere been found to yield less than 19 pence to the cubic yard, whilst large areas of it yield an average of at least a dollar; and many places very much more. The bed-rock value is likely to be much higher; so is that of the actual bed of the stream. An average value of three shillings to the cubic yard is not an extravagant estimate. Of course, local authorities put the average very much higher. At this rate the Incahura basin alone contains £1,500,000 worth of gold. For 100 miles below the Incahuara basin it is believed that the Beni gravels yield gold; there are numbers of places where it has been definitely located, so that, in all probability, the Incahuara basin is a mere fraction, probably not more than the hundredth part of the dredgable ground on the Beni.

On the Inambari, if no spot has been so carefully and elaborately examined as the Incahuara, a much longer stretch of the river has been rapidly sampled by more than one expert, and astonishing values have been revealed—as high, for instance, as 22 shillings to the cubic yard. The Inambari, therefore, is likely to yield as much gold as the Beni. The lower tributaries of both rivers must be included in the calculation, but little more is

known about them beyond the fact that they are margined by gold alluvials.

If this were all, it would suffice to make the prospects of these two river valleys well worth notice; but it must be observed that there is something to be expected from the substance of the hills through which they flow and which they denude. At a point situated between the basins of the Inambari and the Beni (within the watershed, I believe, of the Tambopata) one gold mine has been worked for a series of years by an American company. What its output of gold has been is not stated, but it is known to have been large, and to have run to several millions of dollars. Dr. Evans, during the course of his exploration of the province of Caupolican, observed many signs of old workings in the rocks bordering the Beni. He saw tunnels run into the hill sides and other marks of exploitation. It is unlikely, then, that dredging will be the beginning and end of the exploitation of this region.

As far as our knowledge at present extends all the indications seem to point to the conclusion that this part of the eastern slope of the Cordillera is a real goldfield of great size and importance. Its southern limit seems to lie somewhere about the latitude of Mount Illimani, but as to the limit of its northern extension we know nothing. That it reaches far to the north of the Inambari valley is probable. I have heard of gold-alluvials on the Yucayali river and elsewhere, but all such information is at present of the vaguest; it will probably be long before we have exact knowledge over so large an area, so difficult of access.

It must be remembered that the whole region is enveloped in a dense tropical forest, where prospecting is accomplished in the face of the greatest difficulty. It is only along the banks of the rivers between the levels of high and low water that it has thus far been seriously attempted. That is why our knowledge is practically restricted to the river gravels. As the forests are more developed by the gatherers of india-rubber, as paths are made through them, and spaces opened up for food cultivation, and as population follows these activities and settles around the clearings, discoveries will be made. The climate at the level we are considering—about 1,000 to 2,000 feet above sea—is healthy, and very different from that of the heart of the basin of the Amazon. People can live there all the year round, and once plantations have been cleared, roads made, and suitable houses built, they can live in comfort. All that is wanted is a set of population in this direction. All but the fringe of the northern half of South America and a few of its river banks is hungering for population. It is probably the richest as it is the least developed part of the world. The hope of Bolivia and Peru, so far as the immediate progress of their splendid eastern Cordillera valleys are concerned, is that the gold industry now beginning in those valleys may attain a rapid and conspicuous success.

DISCUSSION.

The CHAIRMAN, in opening the discussion, thought that those who only knew the countries with which the author had dealt in his paper by the accounts of travellers could appreciate from what had been said the real answer to the great problem of how it was that a district which, from before time immemorial almost, had been one of the greatest sources of mineral wealth, had remained unexploited up to the present time. For some hundreds of years before the discovery of America, the district to which Sir Martin had referred was the source of the fabulous wealth of the Incas of Peru, and for hundreds of years after that time it supplied enormous amounts of wealth to the greedy and unscrupulous Spaniards. All the gold was won by a reckless expenditure of human life, and he supposed that when the time came that such a condition was no longer possible the supply fell off, and gold was no longer produced in the same amount; but there seemed every reason to anticipate that with better and more modern and scientific methods large sources of wealth might once more be derived from those ancient districts. It was possible to understand from Sir Martin's description how it was that a district which was cut off on the one side by a barrier of impenetrable mountains, and on the other by thousands of miles of forests, swamps and difficult rivers, had remained so long undeveloped, but there seemed every probability that that condition of things would not much longer exist. He thought there was another cause to which the author had not referred, why the wealth had not been properly developed, viz., not a natural but a human cause. It would be remembered that the first two Spanish expeditions which started south from Peru, one of which went inland, and the other along the coast, were both conquered and practically destroyed by the Indians of the mountains, a race even then very far superior to the mild and gentle inhabitants of the coast regions of Peru; and everyone knew that the Governments in South America had, up to recent times, been of a somewhat unsatisfactory character, and not of the sort which naturally attracted capital. He believed that that state of things was being to a very large extent

changed, and that South American Governments were becoming very much more stable and better in every way, than they used to be.

Mr. F. A. Aramayo congratulated Sir Martin on the excellent paper he had read. It was, he thought, a very exhaustive description of a district which was better known in Europe even than in South America. That the people in this country knew far more about those territories than the people on the spot, was due to the travels of men like Weddell and Sir Martin, who by their contributions to the scientific societies of the world, especially of England, had made the country well known. As a Bolivian, he was glad of the opportunity of thanking Sir Martin for the great contribution he had made to the knowledge of his country.

Mr. W. Bach corroborated everything Sir Martin had said with regard to the country through which he travelled. The author, however, had said very little about the insect life in that part of the world, of which he (Mr. Bach) had some very painful experiences during his journeys, not only on the rivers but also while living in the houses at which he stayed.

Mr. G. W. Sessions said the country Sir Martin had described was one of the most beautiful spots in the world, particularly the lower part of the Inambari river. He wished to confirm everything Sir Martin had said with regard to the presence of gold in the Incahuara river and its tributaries, not one of which had been sampled without large amounts of gold being found. He thought, however, the author made a mistake in stating that the rubber people found the gold in the district described. Two years or more ago, Mr. King, his chief dredging master, and himself visited that part of the country, going over the trails of the rubber company's men to the Inambari; but in addition, they cut their way for twelve or fifteen miles through a region where no white man had travelled before, down to the Chaspa river, where the rubber company's new road now came, so that they were about a year ahead of any of the rubber company's people. He presumed also that Sir Martin referred to the San Domingo quartz mine on the borders of the Upper Inambari and not on the Tamboratna, which was feeding gold into the Inambari river all the time. It might also interest Sir Martin to know that the railway had been completed to Cuzco within the last two months, and that there was a regular service twice a week to the town.

Mr. C. R. Enock said the paper had interested him greatly, as he had recently travelled in the region it described. As a matter of fact he had published two books on Peru which dealt partly with that country, while he had also read papers before the Royal Geographical Society on the subject There was no doubt there was a very important auriferous region, partly in Peru and partly in Bolivia; and that it would take its place in coming years as a gold-producing country. The chief reason why more work had not been done was because the region was so terribly inaccessible; but, as Sir Martin pointed out, there was no doubt the Incas drew great supplies of gold from it. It must be remembered that this gold they drew came from long natural concentrations in the river beds; they did not work quartz lodes but alluvial gravel, and, principally the creek beds, as the Americans termed them, where the gold had been concentrated by Nature and was very rich. Looking at the question from an engineering and commercial point of view, he thought great care must be exercised by companies which embarked their capital in those regions, because extraordinary tales had been told of the fabulous amount of gold which had been taken from river beds. An Indian, with a pan, could wash out gold which would be a very considerable fortune to him; but if a company worked a river bed, they would wash it out in a very short time. That remark applied to what had been termed the torrential regions, rather than the dredging regions, which were much lower down. Dredging offered great possibilities in the future for winning gold, if precautions were taken that the dredgers were not carried away by freshets, and deposited upon great rocks. One or two disasters of that nature had occurred, whereby American capital had been lost. But he thought the principal source of gold in that region would be found in the great hydraulic or alluvial deposits higher up at the heads of the streams. At Aporama there was a remarkable deposit of gold-bearing gravel of very constant value, several shillings per yard, and it was calculated from various reports which had been made that it would take 150 years to work it out, and that it contained gold to the value of about £40,000,000 sterling. Such big figures looked well on paper, but there was no doubt it was a remarkable deposit, which existed under conditions that did not render it risky for capital to work it. In that connection he wished to criticise Sir Martin's statement, that it was impossible to work those deposits by hydraulic methods. At Aporama and in one or two other places work of that nature was done a century ago. The old sluice ways and canals at Aporama were really remarkable works; they had been carried on for leagues round mountain spurs, and in some cases the spurs had been perforated with tunnels, while in other cases they were built up with great aqueducts of stone. It was stated that the works cost half a million pounds, Castelano finding most of the money. They enjoyed good conditions for working, generally rather after the style of the Californian dead river deposits, *i.e.*, they had an ample water supply, and, what was equally important, good means of disposal for the tailings, or from gravel,

boulders, and that sort of thing, which could be thrown over a precipice and carried away by the rivers. There were whole chains of enormous deposits of that nature right along the Cordillera, which formed the limit between Peru and Bolivia. He could call to mind half a dozen huge deposits of that nature of alluvial gravel which had been proved to contain very fair constant values, and huge quantities of material had been washed out. He thought the main sources of gold which could be looked to at first in that region were the great alluvial deposits which lent themselves to hydraulic mining, and, secondly, the great dredging areas which existed where the rivers had entered on to the Amazonian plain, had lost their current, and so deposited their silt and the gold contained in it. After those two great main sources, the quartz lodes, which were found intersecting the country in every direction, would have to be considered. The Chairman had made mention of the question of the stability of South American Governments, and in that connection he wished to take the opportunity of paying a tribute to the Peruvian Government, which at present had entered upon a very stable policy, and one which encouraged investors and foreigners to supply capital for various undertakings. He knew the President who had just been elected, Dr. Leguia, very well personally; he was a most enterprising man, and intended to do well for the country. He also knew his predecessor, Dr. Pardo, and many other public men very well, and they were certainly all imbued with the idea of making their country go ahead, and inviting outside capital, which would be their salvation, because, without capital, the great regions they controlled could not be worked.

Mr. W. Ireden said that one of the main points he had gathered from the paper was that labour was required for the opening up and development of the most interesting country which had been described. He thought there was nothing which contributed, in a young or undeveloped country more rapidly to the economical development of its commercial side than a gold industry. Money was spent in connection with such an industry, so that insurmountable obstacles were got over, roads were established and communications were set up, with the result that products which were abundant, but which it was impracticable to work in the first instance owing to the high cost of bringing them to the market, were able to be dealt with on an economical and profitable basis. It was difficult to criticise the paper on its technical or scientific sides; but he wished to give the caution that where alluvial gold had been found to be of exceptionally high value and very largely distributed over a great area, cases had occurred tending to prove that the reef formation had not finally developed into a great industry. Appearances showed that the reef formations were distributed over higher altitudes, where the denudation and weathering had been carried on to such an extent as to give a favourable concentration in the lower valleys. He could illustrate that by comparing it with a man's hand. In this, there was a vein formation, which was a real and deep mining formation; there was, in a comparatively short length of time, very little denudation, or weathering away, vertically; whereas where veins were more narrowly distributed existed, they were scattered. For a smaller vertical denudation there was a great concentration of alluvials in the lower-lying countries. With regard to the criticism of a previous speaker as to the possibility of developing such countries in the higher altitudes, it appeared to him that in a country, which was difficult of access, the most easily accessible portions should be tackled first, and that, he thought, Sir Martin had done, as he had drawn the attention of the audience to the apparently practical possibilities of developing those resources.

Mr. Emerson Bainbridge said a reference had been made by the Chairman to a very important feature in the paper to which Sir Martin had scarcely referred, namely, the question of the alluvial indicating hereafter the existence of the quartz veins from which the alluvial came; but he thought the sequence had been placed in the wrong direction, because it was quite clear that when alluvial was found anywhere, if investigation was made, some formation, quartz or otherwise, would be found from which the alluvial originally came. From what Sir Martin had said, however, it almost seemed as if the quartz formations were hidden and lost for ever in the eternal snows, and were therefore very difficult to get at. The list of obstacles that Sir Martin had given, the rains, floods, distances, mountains, and all the other obstacles, sufficiently indicated the reason why the gold fields in the regions described had not been worked for so many years. He would like to lay stress on Mr. Enock's remark that 40 million pounds worth of wealth were waiting to be claimed in that part of the world. In these days of depression, it was very cheery to hear that that quantity of gold was available to anybody who had the enterprise to work it. Personally he agreed with the American cynic who said that a gold mine was a hole in the earth, out of which gold was sometimes extracted, but into which gold was generally put. That had been mostly his own painful experience. When he heard Sir Martin describe a gold-field which was apparently four or five times as rich as the alluvial deposits in the Western States of America, he thought the attractions were quite sufficient to overcome the difficulties; and from that point of view he felt very grateful to have had the opportunity of hearing the paper.

Sir Martin Conway, in reply, said he was very glad that Mr. Enock had been able to attend the meeting, because he wished to hear him refer to

Aporama, where there was a very notable accumulation of auriferous gravel, about which he knew nothing. From all he had heard, it was a place of very remarkable exploits in the days of the Spaniards, and he was glad Mr. Enock had given some particulars with regard to it. Mr. Emerson Bainbridge had referred to the difficulties of the region, which were no doubt enormous in the old days when two Cordilleras had to be crossed. Now, however, one of them could be crossed by the railway, and over a great part of the intervening region very good roads had been constructed, which brought the country within relatively easy reach. It cost almost as much to make new roads as it did to make a railway in some places, and once they were made and maintained the difficulty was overcome. The second great difficulty was that when the first portion of the roads were made people found rich gold, and at once exploited it. Expeditions went there in the dry season, who came back and reported what they had found, and ignorant, well-meaning capitalists put their money into what proved to be unfortunate ventures. Now, however, the regions were not casually visited, but there were many people inhabiting them, including managers of important concerns who lived in the country year in and year out, and there was no longer any mystery as to the behaviour of the rivers and the weather at different seasons; so that the difficulties that once existed were comprehended and understood, and their limits had been ascertained. He had no doubt that, in the course of a few years, that region would be as well known to the public as it was interesting to those who had been in it.

The CHAIRMAN, in proposing a hearty vote of thanks to Sir Martin for his interesting and instructive paper, said he believed the author was led to South America by his love for the mountains, and the joy he felt in getting higher up them than anybody else. Many had admired Sir Martin, for years past, as a mountaineer, and he did not think they could wish him anything better than that he might achieve the same success in assisting the development of the district in which he had interested himself, as he had already achieved in subduing the great peaks of Switzerland, of South America, and of the Himalayas.

The resolution of thanks was carried by acclamation, and the meeting terminated.

TRADE OF FLORENCE.

The British colony in Florence increases so fast, that much interest attaches to the last Consular Report for 1907, on its trade and commerce. The province of Florence has a total population of close on a million inhabitants. The Consular district is, however, far larger, extending as it does from Venice, Udine, and Verona in the north, to Elba, Siena, and Ancona in the south. In considering the matter of trade, it is necessary to bear in mind that Italy has, of late years, made prodigious strides in creating manufactures and industries, and that the north of Italy, where fifty years ago there was not a spindle or a loom, is now bristling with cotton and other mills. On the other hand, the large advancement in the national welfare of the country, and her increasing purchasing power, makes her still an important buyer of foreign goods. Florence, with its large and fairly well-to-do foreign element, is, therefore, a good customer, and is also a distributing centre for Tuscany and other districts of Central Italy. But many of the goods destined for Florence are cleared at the frontier, or at the ports of Genoa and Leghorn, this being invariably the case for coal and wheat, and for heavy goods generally, as well as for postal parcels, which are always cleared at the frontier stations.

Some of the chief British products imported into Florence are woollen tissues (£32,700), and in regard to these the United Kingdom holds the first place. But for Italy generally, Germany comes easily to the front, the value of her share of woollen manufactures being £858,200, as against £567,760 for the United Kingdom. The loss of England's former supremacy in this product and her defeat by Germany are ascribed by the Consul-General to the commercial development and export trade of Germany since 1870, especially in tissues for ladies' wear, and the ability and readiness in that country to imitate and sometimes improve on French patterns, with the result that she now occupies the first place on the market, leaving the United Kingdom and France behind. Under the important head of chemical production (including potash and caustic soda, carbonate of soda, sulphate of ammonia and copper, paraffin, soap, &c.), the United Kingdom takes the lead so far as the whole of Italy is concerned, but Florence, probably on account of the comparative paucity of her factories, is debited with but an insignificant proportion of this value. The English figures for Italy are £1,143,120, as against Germany's £916,580, and France's £535,040. In the matter of cotton goods, Germany is first and England a bad second, both in regard to Florence and Italy generally.

With reference to the imports of paper and books, the Consul-General supplies a practical illustration of the want of British enterprise. When he had occasion to renew an apartment in the autumn, he inquired, when selecting wall papers, the place of origin of each paper, and found they came from France, Germany, or Belgium, but not a single roll of any sort came from the United Kingdom. Under the important head of minerals, metals, and articles manufactured therefrom, the United Kingdom is outstripped by Germany and France as purveyors of Florence's requirements, but for the whole of Italy our country holds the second place, France being a rather poor third. The jewellery trade in Florence is of considerable importance, and the imports of

precious stones of all kinds, unset, cannot be under £120,000 or £150,000 per annum. The most valuable stones come chiefly from France, and to a small extent from the United Kingdom, while the semi-precious stones, such as opals, topazes, &c., come chiefly from Germany. On examination of the imports into Italy, we find a diminution of 241 tons of China clay (kaolin), but a considerable increase in firebricks, from the United Kingdom. British coal, again, is steadily on the increase, and reaches nearly £8,000,000 in value.

House building to a considerable extent is going on in the large areas outside the boulevards, but in the most central part of Florence there is hardly a new house being built for letting purposes, and the demand for comfortable flats from seven to twelve rooms, especially for the professional classes, in the central streets, is very great.

There are new railway lines in contemplation, viz., a direct one between Bologna and Florence to relieve the present line of its excessive traffic, and another from Lucca to Aulla, which will relieve the Spezia-Pisa line, and be of great advantage to the marble quarries lying between the Apuan Alps and the Apennines. There is also a strong movement on foot for the improvement of the navigation of the Arno and its auxiliary canals, which owing to the bad condition of the towing paths, banks, walls, sluices, and other works, is in a deplorable condition.

Co-operative societies are largely on the increase, not only in the Florence district but throughout Italy, for whereas at the close of 1889 there were only two such productive centres, at the close of 1907 there were over 400, the greater part of these being in the Reggio Emilia and Venetia.

BULGARIA AND BRITISH TRADE.

In the past year the exports of the United Kingdom to Bulgaria showed an increase of some £73,000 as compared with the figures of the preceding year, but this increase is due almost entirely to the Bulgarian Government itself which, owing to the strike at the Government coal mine at Pernik, ordered large quantities of Cardiff coal for the Bulgarian State railways, and large quantities of British rails for two of the railway lines in course of construction—Tirnovo-Stara Zagora and Devna-Dobritch. On the other hand, nearly all the classes of textile goods which form the bulk of the United Kingdom's import trade to Bulgaria showed a marked decrease. In commenting upon this decrease as against the increase in imports from Austria and Germany, Mr. Vice-Consul Toulmin, in his report just published (No. 4132, Annual Series), ascribes it in large part to the unwillingness of British traders to adapt themselves to the trade customs of the country. For example, in the matter of trade facilities, credit plays a most important part in a country like Bulgaria where capitalists are few and turnover is slow. The outcry against the conditions of trade, viz., net cash, is heard, says the Vice-Consul, on all sides, and it behoves British manufacturers to adhere less rigidly to their ultra-cautious system of cash payments in view of the generous facilities extended to customers in Bulgaria by their foreign rivals, who allow six months', and sometimes even longer, credit. America, for example, sends large quantities of agricultural machinery into Bulgaria on a two years' credit system, and the factories interested send their representatives to Bulgaria to study the conditions on the spot, and to collect all possible information as to the integrity and financial standing of the dealers in whose hands the machines are placed. This enables farmers to extend their payments over two, or even three harvests. Again, the Vice-Consul directs attention to the hopelessness of the British manufacturer sending English price lists, trade circulars, &c., with English weights and measures. These, if they are to serve any useful purpose, must be translated into French, with prices marked in francs and centimes, weights in kilograms, and measures in metres. A large quantity of catalogues are annually received in Bulgaria which, if they had been drawn up in any language but English, might with advantage have been passed on to the Chamber of Commerce, Bulgarian Ministers, and private firms, but the Vice-Consul says that during the last seven years only one price list which has fulfilled the above conditions has been received from a British firm.

The absence of a British bank also contrasts unfavourably with the enterprise of other countries. These banking institutions, apart from the important share they take in developing the internal resources of the Principality, and in bringing the Bulgarian market into more immediate touch with foreign manufacturers, are in an eminently suitable position for giving information respecting the financial standing of local firms, and thus enable manufacturers abroad to extend or curtail their credit facilities to dealers in Bulgaria. Another important factor which contributes to the development of Austro-Hungarian trade at the expense of British is the Austro-Hungarian Commercial Museum, established in the capital, with branches in the chief towns of Bulgaria. The depots, containing every variety of Austrian and Hungarian wares, have only to be visited by intending buyers, who see at a glance what they require, and have the advantage of being able to examine thoroughly and handle the goods before purchase. This institution is reported to have done excellent business in 1907, and the want of a similar establishment for the display of British goods is much to be regretted. By the employment of commercial travellers—less than half a dozen British commercial travellers visited Bulgaria in 1907—the establishment of a British bank and sample museum, the translation of catalogues into French or German, and the use of these languages in contracts, the adoption of the metric system of weights and measures, the conversion of sterling into francs and centimes, by careful

and attractive packing, by strict attention to the supply of goods according to sample, and by according greater credit facilities—by these means only, in the opinion of Vice-Consul Toulmin, can British manufactures hope to compete successfully with their foreign rivals.

STATE ASSISTANCE TO GERMAN ARTIZANS.

There is no nation in the world that gives greater encouragement and opportunity to its people to become skilled artizans than Germany. Municipal, State, and the Federal Governments all contribute to the establishment and support of technical and industrial schools, and there is scarcely a town or city of any importance where one of these institutions is not to be found. Any law or regulation that tends to encourage and assist labourers and mechanics to a higher degree of proficiency finds ready and hearty endorsement. The Department of the Interior of the Imperial Ministry of Alsace-Lorraine has arranged courses of instruction for those workers who desire to attain that degree of proficiency which will entitle them to be called masters in their respective trades. It must be understood that the applicants for the masters' degrees are practical and skilled workmen, with years of experience in their different branches of work, and by means of these tests are ambitious to become recognised as finished artizans. For instance, a tailor who has successfully passed such a test will be known as "Schneidermeister" (master tailor), and since such distinctions mean a great deal to a workman in Germany, the artizan eagerly strives to attain that proficiency when he is recognised as master of his trade. The American Consul at Kehl says that beside the excellent trade schools and the necessity of long apprenticeships, which train the journeymen of Alsace-Lorraine, the Ministry at Strasburg has prescribed the following courses:—(1) A master course for bookbinders, upon the completion of which the workman is known as a master bookbinder. This course is conducted in Strasburg by an expert instructor from an industrial school of North Germany. Instruction is given in the details of binding books, especially the different colour effects, artistically cutting the paper—square-cornered or round—the art of putting the leaves together in such a way as to ensure greater symmetry and durability; the tasteful decoration of the cover; the study of the different kinds of binding, such as leather, half-leather, morocco, cloth, paper, &c.; the class of bindings that are best suited to an atlas or album; the study of attractively indicating the title of the book; the best method of dividing a large work into volumes. Besides these practical phases, lectures are given, and exhibitions are held of of the best products in the art of bookbinding. (2) In the courses for tailors, most of the attention is devoted to the instruction in cutting and fitting, the drawing of the latest patterns, &c., as well as the studying of the quality of goods and colour effects. (3) The master course for painters, consists of practical lessons in wood and stone painting, proper shading, and the painting of figures, signs, and other artistic work. Exhibitions are also held in different public places, when the painters names are indicated, and in this way serve, in a certain sense, to advertise their work—though that is incidental. (4) A master course for locksmiths, mechanics, plumbers and tinners, is given in the fundamental studies of electricity, building and insurance requirements, as well as the proper wiring of buildings. The installation of telephones, different methods of lighting—gas or electricity. Practical illustrations are taken from model houses and buildings. (5) A master course for cabinetmakers, in which the latest tools, different kinds of wood, and their respective uses, and practical work in polishing and staining of wood, as well as the study of the latest material in the finer woods for such work. Further each participant must be able to sketch a model workshop, figure out the cost of the raw material compared to the finished product, and visits are made to the art museums and large furniture establishments. (6) Similar courses are given for paperhangers, decorators, potters, carpenters, well diggers, and all workmen where any skill is required.

THE NORTHWARD EXPANSION OF CANADA.*

At its formation in 1867, Canada extended from the Atlantic to Lake Superior; by the purchase of its rights from the Hudson's Bay Company in 1869, and by union with British Columbia in 1871, it reached the Pacific. But a country is really measured not in square miles, but in the area which men can inhabit and develop. At federation the inhabited country was but a thin and broken strip along the American frontier. Wildernesses separated the maritime provinces from Quebec, and Ontario from the West; from Winnipeg to the Rocky Mountains was the home of a few Indians; three ranges of mountains shut in British Columbia. North of the "Height of Land" in Ontario and Quebec all was wilderness. Canada was length without breadth, and even the length was not continuous.

The progress of the country has consisted not so much in any change of climate or of geographic conditions as in (1) the spread of knowledge as to what the conditions really are; (2) with the growth of knowledge the growth of popular confidence; (3) the conquering of such conditions as were favourable. Man is to-day the ruler, not the slave, of geographic conditions. He is no longer forced to follow the rivers; settlement no longer creeps from point to point. The railway goes hundreds of miles in advance of settlement, and everywhere finds land where men may live and prosper. The new transcontinental railways pass through the province of Alberta more

* Abstract of a paper read before the Geographical Section of the British Association, Dublin, 1908, by W. L. Grant.

than 309 miles north of the American frontier, and already settlement has extended north of the railways. In Ontario and Quebec, north of the Height of Land, great tracts are being opened up by new railways, and are being found rich not only in minerals and in timber, but also in arable land. A study of railways is to-day more important than a study of rivers.

With this widening of habitable territory goes an increase in political and economic unity; that which was at first only a paper federation is being welded together.

At the heart of this network of railways lies Winnipeg, the central city of Canada. The railway map of Canada is in shape not unlike a wasp, with its waist at Winnipeg. Perhaps the greatest danger to which Canada is exposed is that the waist may be too small. A railway running north of Lake Winnipeg should be one of the next links forged in the building together of Canada.

THE DECLINE IN THE MEERSCHAUM INDUSTRY IN GERMANY.

According to recent reports it would appear that the meerschaum industry in Germany is in a critical condition. The American Consul at Annaberg says that the manufacturers of meerschaum pipes, cigar holders, &c., are unable to secure anything like an adequate supply of raw material, and for the trifling quantities they can secure, they must pay a greatly increased price. In the last three years, prices of raw meerschaum have about doubled, and, at the same time, America and England have secured control of practically all the meerschaum still to be had. Recently, a small shipment has been received in Germany from Asia Minor—the first for some time. An advance of about 30 per cent. in price immediately followed. Practically all known deposits of meerschaum have been exhausted. Agents of American and English manufacturers have secured control of this entire output, and German manufacturers can count on no more supplies from that source. The manufacturing town of Ruhla, in the Thuringian forest, will be the most affected. There from 3,000 to 4,000 workmen have, for years past, been employed in this industry. A Ruhla specialty is the meerschaum pipe, and with it goes, hand in hand, the manufacture of pipe stems, pipe lids and mountings, cigar holders and mouthpieces. The annual output averages about 27 million pipe lids, 19 million pipe cases, 15 million pipe stems, 10 million mouthpieces, 10 million porcelain pipe bowls, 5 million imitation, and 540,000 genuine meerschaum pipes with amber mouthpieces, 5 million wooden pipe bowls, and 15 million completed pipes—a production of about the value of about £300,000 per annum. The first meerschaum factories were founded in Ruhla in 1767. For the inhabitants of this district, the passing of the meerschaum industry is a blow from which it will be difficult to recover, practically the entire population being dependent on this industry.

HOME INDUSTRIES.

German Competition. — In discussing the effect of the new Patent Act upon British industries it has been suggested more than once, that the advantage, whatever it may be, of compelling German patentees, who wish to keep their patents in this country alive, to put up works within the United Kingdom may be more than counterbalanced by the stimulus such extensions will give to foreign competition, and there are signs that this consideration is beginning to weigh with business men. About four months have passed since the Act became law, and a considerable number of foreign—chiefly German—firms have been forced to settle down in England. They have invested a large capital, and will employ a certain amount of British labour. Others will come —old firms with wide world reputation, and new firms formed specially for the purpose of complying with the Act. The danger of competition from these foreign firms seems a very real one, and it can only be met by English manufacturers rousing themselves to the necessities of the situation, and meeting their German and other rivals on their own ground of efficiency and enterprise.

Universities and Organic Chemistry.—In this connection it is satisfactory to note that the chemical schools at the Manchester University are being enlarged by the addition of a new block of buildings, which it is expected will be ready for opening in the early autumn of next year. The main part of this new block will consist of a large laboratory for 40 students and 15 research laboratories. Some remarks by Professor W. H. Perkin at the recent meeting of the Society of Chemical Industry, on the general question of the bearing of chemical research on industry deserve notice. The professor dwelt particularly with the reason why we lost and Germany gained the coal-tar industry. He differs from the accepted opinion, that the manufacturers of this country are entirely responsible for the loss of this industry, holding that the universities have been greatly to blame in the matter. It was impossible for the works to be carried on successfully in competition with the industry in Germany unless a number of first-rate chemists could be obtained and employed in developing the existing processes and in making new discoveries. But young men were not trained at our universities in the methods of organic chemistry. It was hardly recognised in the older universities, and the newer ones had not come into existence. As a matter of fact, even to-day organic chemistry does not flourish in many of our universities as it does in almost every university on the Continent. The German manufacturer, beginning in a small way, made liberal use of the young research chemists who were being trained in the German laboratories, and we see the result in the supremacy won and maintained by Germany in this department of industry. Happily Manchester at least has fully recognised the importance to our home industries of the teaching of organic chemistry.

Textile Machinery Exports.—Although in most departments of home industries serious shrinkage is to be noted as compared with last year, textile machinery exports continue to expand. The declared value of the exports of this special group during last month was £819,019, as compared with £752,526 for the corresponding month of last year, and £617,150 for October, 1906. The total value of British machinery exported during the expired ten months of this year is given as £7,392,795, against £6,630,155 for last year, and £5,467,884 for 1906, the increase being at the rate of about one million sterling per annum. Germany is almost the only country in Europe which shows a falling off as compared with last year, and if we compare the figures of the present year, £85,680, with those of 1906, £73,620, there is substantial gain. The exports to the United States has fallen from £50,771 in 1906 to £31,262 in 1908, and although those to South America are higher than in 1906, they show a substantial decrease upon those of 1907. To almost all other countries there is considerable increase, more especially to Japan and Russia. Even the exports to Germany are really larger than they appear to be from the official figures, since a certain quantity pass through the Netherlands, and are credited in the statistics to that country.

The Taxi-Cab Industry.—Proof of the rapid increase in the number of taxi-cabs upon the streets may be found in the order recently promulgated which reverses the usual whistle signals given for calling vehicles, the three blasts which has hitherto been the sign for a motor-cab being changed to the single blast used for a horse vehicle, or *vice versâ*. The public have taken to these cabs, and recent reports of the Companies owning them show that they are being run at a substantial profit. In these circumstances it may safely be assumed that a much larger number of taxi-cabs will soon be upon the streets, and that promoters will be busy with appeals to the public to find the necessary capital. Investors will, however, do well to remember that though some of the causes which have made the motor-omnibus so disappointing from the financial point of view are absent, it has still to be proved that the taxi-cab can be run at substantial profit upon present fares. It is reasonable to expect that depreciation will be much less than with the motor-omnibus, but as to the length of life that may safely be anticipated there is as yet little knowledge. Engines and gears which do well when first new may give very different results when the newness is worn off. And there is the prospect of excessive competition. It is not impossible that the same number of motors will displace the existing number of horse cabs, and it would be unsafe to assume that the public will use cabs in the future much more frequently than in the past. And every taxi-cab can do the work of three of the old-fashioned horse cabs. Things will right themselves in the end, but meantime investors will do well to recognise the necessarily risky character of investments in taxi-cab companies, and avoid those which are not controlled by strong Boards.

The Cotton Industry.—Exports of piece-goods for October show considerable decline as compared with the same month of last year, as from 528,680,500 yards to 455,686,700 yards, the shrinkage in the ten months being from 5,304,227,200 to 4,765,087,700 yards. The shipments of yarn, too, have been on a smaller scale, and have decreased from 21,836,200 lbs. in October, 1907, to 16,764,200 lbs. last month. The markets are, however, beginning to show more life, and the reports of the American cotton crop leave little to be desired. According to Messrs. Hubbard Brothers and Co., of New York, the present crop is the largest ever grown. The weather since the beginning of the picking season has been perfect for the maturing and gathering of the crop. Crops which appeared doubtful a month ago, are now said to be assured and gathered. It is estimated that the consumption of cotton this season—allowing a decrease of 300,000 bales as a consequence of the lock-out—with the mills all running as they did in 1906-7, will be about 12,400,000 bales; and with stores depleted, and trade showing some signs of improvement, the outlook for Lancashire is considerably brighter.

OBITUARY.

Robert Hovenden.—The death took place, on the 23rd inst., in his 79th year, of Mr. Robert Hovenden. He was the head of the well-known firm of hairdressers' sundriesmen, which started in 1866 the first newspaper for the trade. He has been a member of the Society since 1871. He was also an industrious antiquary, taking great interest in genealogies and parish registers, and was for ten years a Fellow of the Society of Antiquaries.

NOTES ON BOOKS.

Chip-carving and other Surface Carving. By Eleanor Rowe. London: Batsford, 1s. net.

This little volume is written to take the place of the author's earlier book, "Hints on Chip-carving," which, after running through several editions, is now out of print. It covers somewhat different ground from its predecessor, and the space gained by omitting a chapter on geometrical drawing is usefully devoted to discussing strap work and other forms of simple low relief carving not quite so formal in character as ordinary chip-carving. Miss Rowe treats her subject throughout in a thoroughly practical

workmanlike spirit, and her book should be of the greatest assistance not only to those beginning the study of wood-carving, but also to teachers of the simpler branches of the craft. It would be a good thing if more amateurs followed the author's advice, and remembered that surface-carving is very much more suitable for tables, chairs, and so forth, "than the carvings in high relief which are so often seen at local exhibitions," simple carving in low relief is within the capacity of most people, and is very much more pleasing than ambitious attempts at high r elie badly or indifferently executed. It is interesting to notice that, whilst in the old book it was taken for granted that the chip-carver's tools were inevitably the chisel and the veiner, Miss Rowe now suggests that at any rate beginners with no experience of tools should work with a knife.

GENERAL NOTES.

Opium.—The question of the opium traffic in all its bearings has been so fully discussed on all sides during the past year that the report of Mr. Archibald Rose, of His Britannic Majesty's Consular Service (No. 4108, New Series) upon the immediate results from a purely commercial point of view will be read with interest. The famous decree from Peking of September 20, 1906, proposed the entire abolition of opium within ten years, and in October, 1907, and April, 1908, further decrees gave evidence of the desire of the Chinese Government to carry out its purpose. The ratepayers in the International Settlement of Shanghai have decided to commence restrictive measures by closing 25 per cent. of the licensed houses under municipal control; and though it is difficult to obtain statistics on the decrease in consumption throughout the Empire, Mr. Rose says it is clear that a definite move has been made in the policy of abolition. The course of the opium market during the year has been largely influenced by these facts, and importers have also based their action largely on the action of the Government of India, which has reduced the export of opium to China by 5,100 chests annually. In July the Viceroy of Nanking proposed a Government monopoly, and this was sufficient to reduce the prices sharply, both in the Patna and Benares product, though they reached a higher level than usual by the end of the year, when the proposal was known to have been definitively abandoned. Malwa opium was similarly affected, and the deliveries both of Malwa and Benares opium declined by about 1,000 chests each on last year's figures for the five months ended May, 1908. The presence of numerous medicines in the native drug shops containing a heavy percentage of morphia is not without interest at this period, and the fact that no morphia return appears in the Customs statistics proves the ease with which this product can be smuggled into the country.

Wages and Living in Japan.—The very low wages paid to Japanese workmen is a considerable factor in the competition between Japan and ourselves for the trade of the East, but it looks as if, in this respect, the disparity is becoming less. In his report on the trade of the Consular District of Yokohama, just issued (Annual Series, No. 4165), Mr. Vice-Consul Harrington says that the average rate of wages in Japan has taken a special step upwards. Taking the rate of wages in 1892 as the standard, the average rate of wages for 38 classes of workmen in Yokohama had increased in 1906 16·95 per cent., and in 1907, 30·27 per cent. Of the 38 classes only four showed a decrease in the figures of 1902, the increase being fairly well distributed over all classes. As compared with British standards, however, the rates of wages for labourers are still very low, the standard of living in matters of food, clothing, &c., amongst the classes in Japan remaining correspondingly low. But the standard is certainly advancing, so that it is probable that wages will continue to increase. And the cost of living is rapidly rising. Taking 1902 as the index year, of 37 ordinary articles of food, clothing, household tax, &c., the average cost had increased 21 per cent. in 1906, and 31·6 per cent. in 1907.

The Russian Spirit Monopoly.—How greatly the spirit monopoly increases the resources at the disposal of the Government of Russia, and how rapidly it is growing, may be gathered from figures supplied by Mr. H. O'Beirne, Councillor of His Majesty's Embassy at St. Petersburg, and just made public (Annual Series, No. 4163). This monopoly was introduced in 1905, and gradually extended throughout the empire. It is at present in force over the whole of Russia with the exception of the Trans-Caucasus, Turkestan, the Amur District, the Trans-Caspian, and Semirctchusk territories. The alcohol is manufactured for sale to the State according to a plan approved by the Finance Ministry, the amount required being apportioned among the local distilleries, and the price fixed by the Government. State establishments transform the refined alcohol thus obtained into vodka, and the Government sells the product wholesale and in retail. The receipts from the monopoly increased from £50,000,000, in 1902, to £74,400,000 last year. In the earlier part of that period the great increase in receipts arose from the gradual extension of the monopoly; lately it is accounted for chiefly by increased consumption and a rise in the price of the liquor. Expenses have increased from £16,600,000 in 1902, to £18,700,000 in 1906. Before the introduction of the monopoly in 1895 the yearly revenue derived by the Government from excise and licenses on spirits was about £30,000,000. The payments in compensation to individuals and institutions deprived of the exclusive privilege to sell liquor are estimated in the current year at £300,000. They are now practically liquidated.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock :—

December 2.—"Mechanical Flight." By Eric Stuart Bruce, M.A. William Napier Shaw, Sc.D., F.R.S., will preside.

December 9.—"Kinematography in Natural Colours." By G. Albert Smith, F.R.A.S., and Charles Urban, F.Z.S. Sir John Cameron Lamb, C.B., C.M.G., Member of the Council, will preside.

December 16.—"London Milk Supply from a Farmer's Point of View." By Primrose McConnell, B.Sc., F.C.S. Sir George Barham, J.P., President of the British Dairy Farmers' Association, will preside.

Indian Section.

Thursday afternoon, at 4.30 o'clock :—

December 10.—"The Birds of India." By Douglas Dewar, I.C.S.

Cantor Lectures.

Monday evenings, at 8 o'clock :—

Oscar Guttmann, M.Inst.C.E., F.I.C., F.C.S., "Twenty Years Progress in Explosives." Four Lectures.

Lecture II.—November 30.—Manufacture of nitroglycerine — Use of anhydrous sulphuric acid—Displacement process—Abolition of after-separation —Dynamites—Unfreezable nitroglycerine explosives —Guncotton—Selection of cotton—Acid mixtures—Apparatus—Percentage of nitrogen—After-treatment —Nitrostarch.

Lecture III.—December 7.—History of smokeless powders—Their manufacture—Flameless powders —Fulminates and detonators — Fuses — Safety explosives.—What renders an explosive safe in fire damp?—When is an explosive safe?—Coal dust—Safety explosives in practice.

Lecture IV.—December 14.—Use of nitrocellulose for celluloid, artificial silk and varnish—Machinery driven by explosives—Factories, their inspection, construction and accidents—Precautions recommended — Electric lighting — Static electric charges—The merits and demerits of explosives—Stability and its proof—Stability in practice—Accidents with smokeless powder — Stabilizers — The powder of the future.

G. L. Addenbrooke, M.I.E.E., "Electric Power Supply." Three Lectures.
January 18, 25, February 1.

Leon Gaster, A.M.I.E.E., "Methods of Artificial Illumination." Four Lectures.
February 15, 22, March 1, 8.

George Gerald Stoney, M.Inst.C.E., "Steam Turbines." Three Lectures.
March 22, 29, April 5.

F. W. Lanchester, "Aerial Flight." Three Lectures.
April 26, May 3, 10.

Juvenile Lectures.

Two Lectures suitable for a Juvenile audience will be delivered on Wednesday afternoons, January 6 and 13, 1909, at 5 o'clock.

MEETINGS FOR THE ENSUING WEEK.

Monday, Nov. 30...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. O. Guttmann, "Twenty Years Progress in Explosives." (Lecture II.)
Geographical, Burlington gardens, W., 8½ p.m. Dr. Vaughan Cornish, "The Panama Canal in 1908."
London Institution, Finsbury-circus, E.C., 5 p.m. The Earl of Ronaldshay, "Railway and Commercial Enterprises in China at the Dawn of the 20th Century."

Tuesday, Dec. 1...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. D. A. Matheson's paper, "Glasgow Central Station Extension."

Wednesday, Dec. 2...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Eric Stuart Bruce, "Mechanical Flight."
Royal Archæological Institute, 20, Hanover-square W., 4½ p.m. Dr. A. C. Fryer, "A Note on a Leaden Font at Haresfield."

Thursday, Dec. 3...Linnean, Burlington-house, W., 8 p.m. 1. Dr. G. Herbert Fowler, "Biscayan Plankton: The Ostracoda." 2. Mr. Bunzo Hayata, "Note on *Juniperus taxifolia*, Hook and Arn." 3. Mr. R. J. Pocock, "Mimicry in Spiders."
Chemical, Burlington-house, W., 8½ p.m. 1. Messrs. J. E. Marsh and R. de J. Fleming-Struthers, (*a*) "Double Salts of Potassium Iodide with Mercury Iodide and Camphor Dimercuriodide in Organic Solvents." (*b*) "Action of Mercuric Iodide on Ketones in Alkaline Solution." (*c*) "Condensation of Camphor with Mercuric Iodide." 2. Messrs. E. C. C. Baly, J. N. Collie, and H. E. Watson, "The Relation between Absorption Spectra and Chemical Constitution." Part XIII. "Some Pyrones and Allied Compounds." 3. Messrs. G. T. Morgan and Miss F. M. G. Micklethwait, "Organic Derivatives of Arsenic." Part I. "Dicamphorylarsinic Acid." 4. Mr H. E. Cockedge, (*a*) "Tellprian Dicyanide." (*b*) "Boron Thiocyanate."
London Institute, Finsbury-circus, E.C., 6 p.m. Mr. F. H. Jackson, "Cattaro and Ragusa: the Cities, the Country, and the People."
Civil and Mechanical Engineers, Caxton Hall, Westminster, S.W., 8 p.m. Mr. J. Sutherland Warner, "The Influence of Track upon Railway and Tramway Carriages."

Friday, Dec. 4...Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. L. W. Atcherley, "The Design and Erection of a Plate-Girder Bridge over the River Lea, at Broxbourne."
Art Workers' Guild, Clifford's-inn-hall, Fleet-street, E.C., 8 p.m. Paper on "Political Cartoonists."
Architectural Association, 18, Tufton-street, S.W., 7½ p.m. Mr. W. Dunn, "Early Studies and Future Practice."

Saturday, Dec. 5...Educational Handiwork Association (At the House of the Royal Society of Arts, John-street, Adelphi, W.C.), 3 p.m. Dr. F. W. Mott, "The Brain and the Hand."

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FRIDAY, DECEMBER 4, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, DECEMBER 7, 8 p.m. (Cantor Lecture.) OSCAR GUTTMANN, M.Inst.C.E., F.I.C., F.C.S., "Twenty Years Progress in Explosives." (Lecture III.)

WEDNESDAY, DECEMBER 9, 8 p.m. (Ordinary Meeting.) G. ALBERT SMITH, F.R.A.S., and CHARLES URBAN, F.Z.S., "Kinematography in Natural Colours."

THURSDAY, DECEMBER 10, 4.30 p.m. (Indian Section.) DOUGLAS DEWAR, I.C.S., "The Birds of India."

Further details of the Society's meetings will be found at the end of this number.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience, will be delivered on Wednesday afternoons, January 6th and 13th, at 5 o'clock, by Charles Waldstein, Litt.D., Ph.D., Slade Professor of Fine Art in the University of Cambridge, on "Digging for Ancient Art Treasures."

Each Member is entitled to a ticket admitting two children and an adult.

A sufficient number of tickets to fill the room will be issued to Members in the order in which applications are received.

Members who desire tickets for the course are requested to apply for them at once.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready and can be obtained by members on application to the Secretary.

CANTOR LECTURES.

On Monday evening, 30th inst., Mr. OSCAR GUTTMANN delivered the second lecture of his course on "Twenty Years Progress in Explosives."

The lectures will be published in the *Journal* during the Christmas recess.

PROCEEDINGS OF THE SOCIETY.

THIRD ORDINARY MEETING.

Wednesday, DECEMBER 2, 1908; WILLIAM NAPIER SHAW, D.Sc., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Haigh, George, Norwood-mills, Southall, Middlesex.
Hardee, Oscar, Summerhill-lodge, Chislehurst.
Harrison, P. Walton, County Surveyor's Office, Norwich.
Hewett, Bertram H. M., A.M.I.C.E., M.Am. Soc. C.E., 564, West 33rd Street, New York City, U.S.A.
McCarthy, Edward Valentine, J.P., Ardmanagh-house, Glenbrook, Co. Cork, Ireland.
Osborn, N. F. B., 11, Bruce-grove, Tottenham, N.
Rosenfeld, Benedict, 8, Lindfield-gardens, Hampstead, N.W.
Stokes, Rear-Admiral Robert Henry Simpson, R.N., Junior United Service Club, Charles-street, St. James's, S.W.
Taylor, Charles Davenport, 11, Stafford-terrace, Plymouth, and Santa Ann, California, U.S.A.

The following candidates were ballotted for and duly elected members of the Society:—

Abrahams, Arthur Edward, 5, Tokenhouse-yard, E.C.

Allum, Ernest Frederick, Pali Hill, Bandra, near Bombay, India.

Babington, Eustace B., Elm avenue, Long Eaton, near Nottingham.

Ballon, Walter Seymour, Providence, Rhode Island, U.S.A.

Barlet, Stéphane, 97, St. Mark's-road, North Kensington, W.

Beede, Herbert Gould, Pawtucket, Rhode Island, U.S.A.

Beesley, Frederick, 2, St. James's-street, Pall-mall, S.W.

Behrens, Captain Clive, J.P., Swinton Grange, Malton, Yorks.

Benson, Davis Edmondson, Assoc.M.Inst.C.E., 12, Irton-road, Southport.

Bharucha, Rustomji Edalji, Cumbala Hill, Bombay, India.

Booth, George T., Messrs. Booth, Macdonald and Co., P.O. Box 99, Christchurch, New Zealand.

Boyd, William Beverley, Toronto Railway Company, Toronto, Canada.

Brown, William Love, 9, Garden-street, Montclair, New Jersey, U.S.A.

Buchanan, George C., M.Inst.C.E., Chairman, Port Trust, P.O. Box 85, Rangoon, Burma, and East India United Service Club, St. James's-sq., S.W.

Caddick, Arthur, Arboretum-lodge, Lincoln.

Calmon, Dr. Miguel, Gabinete do Ministro da Industria, Rio de Janeiro, Brazil, South America.

Cohen, George A., 71, Portland-place, W.

Cooper, George Seton Halcott, The Natal Brewery, Pietermaritzburg, Natal, South Africa.

Cosgrave, William A., Manipur, Assam, India.

Cunningham, William M., M.A., 174, North Fourth-street, Newark, Ohio, U.S.A.

Davis, E. A., Fernando Po, South-West Africa.

Dorn, Felix, 21, Belsize-square, N.W.

Elles, E. H., 6, Short-street, Calcutta, and Messrs. Pigott, Chapman, and Co., 1, Mission-row, Calcutta, India.

Gardner, Walter Silvester, 16, Finsbury-circus, E.C.

Garland, Frederick Joseph, M.I.Mech.E., The Water Works, Frimley-green, Surrey.

Gawthorp, Thomas George, 16, Long-acre, W.C.

Gehrke, A. H., 218, Denmark-hill, S.E.

Gray, William, 132, Packington-street, Islington, N.

Howard, Miss Rose Lilian, Apartado 1669, Mexico D.F., Mexico.

Un Yuen Hsu, B.A., care of Chinese Legation, 49, Portland-place, W.

James, Sir Henry Evan Murchison, K.C.I.E., C.S.I., Glenshee, Cambridge-park, Twickenham.

Johnston, Alderman Charles, 17 and 18, Aldersgate-street, E.C.

Jones, Rev. Robert Francis, 11, Thorburn-square, Bermondsey, S.E.

Jones, W. J. H., Hurlingham-lodge, Fulham, S.W.

Kranz, William G., Sharon, Pennsylvania, U.S.A.

Lane, Hugh P., 93, Jermyn-street, S.W., and Royal Societies Club, 63, St. James's-street, S.W.

Law, William Henry, Virgil Works, 34, Eyre-street, Sheffield.

Lingham-Lees, J., B.A., Clyde-house School, Hereford.

Lloyd, Captain M. B., Messrs. Curtiss and Harvey, 3, Gracechurch-street, E.C.

Loring, Lieutenant Frederick George, R.N., Secretary's Office, General Post Office, E.C.

Love, James Black, M.A., Tientsin, North China.

McLeod, James Morrison, 2, Hilldrop-road, N.

Majumdar, Kedarnath, M.R.A.S., Mymensingh, India.

Mallock, Henry Reginald Arnulph, F.R.S., 6, Cresswell-gardens, S.W.

Meelboom, John A., Ferro Carril Buenos Aires and Rosario, Buenos Aires, Argentine Republic.

Melville, J. Stark, 10, Blythswood-square, Glasgow.

Mesens, Mademoiselle Jeanne, 79, Rue des Rentiers, Brussels, Belgium.

Monteath, Sir James, K.C.S.I., Bellair, Charmouth, Dorset.

Moody, George H., A.M.I.Mech.E., Westholme, Bradley, Bilston.

Nariman, R. K., Assoc.M.Inst.C.E., 9, Pall-mall, S.W.

Nathani, M. R., Kiponda-road, Zanzibar, British East Africa.

Noakes, Lieutenant G. H., R.N.R., New Zealand Shipping Company, 138, Leadenhall-street, E.C.

Orr, Robert M., The United Railways of Havana, Havana, Cuba, W. Indies.

Oswell, George Devereux, M.A., Rajkumar College, Raipur, Central Provinces, India

Panter, Frederick Richard, May-lodge, Upminster, Essex.

Pastakia, Jamsetji Jejeebhoy, Kavrana's building, Colaba, Bombay, India.

Petrie, William Wilson, 25, Finsbury-circus, E.C.

Pitt, Philip Septimus, M.A., 3, The Oval, Stafford.

Quah Beng Kee, 41 and 43, Beach-street, Penang, Straits Settlements.

Reuben, Simon, Anajee Soonder-road, Tembi, Thana, viâ Bombay, India.

Robertson, Rev. Dr. David, M.B., Ch.B., Itu, Southern Nigeria, West Africa.

Rodrigo, Arthur Colin, 15, 44th-street, Rangoon, Burma.

Seppings-Wright, F. T., Koraput P.O., Vizagapatam District, South India.

Shafi, Khan Bahadur Mian Muhammad, Baghbanpura, Lahore, India.

Simpson, Colonel C. N., Army and Navy Club, Pall-mall, S.W.

Simpson, Samuel, B.Sc., Wiswell, Whalley, Lancashire, and Zomba, Nyasaland, Africa.

Singh, Dr. Dais Raj Ranjit, L.M.S., 1, Stanley-road, Allahabad, India.

Sloper, Percy, 2, Colville-gardens, W., and Devonshire Club, S.W.

Smith, Charles H., Philippine Judiciary, P.O. Manilla, Philippine Islands.
Smith, Eden, 199, Yonge-street, Toronto, Canada.
Stanton, Albert Lennox, 13, Hyde-street, King's-road, Southsea.
Stephens, Robert, R.I.E.E., 57/2, 36th-street, Rangoon, Burma.
Steward, Henry Allan, Postford-house, Chilworth, Surrey.
Tan Jiak Kim, The Hon., Panglima Prang, 115, River Valley-road, Singapore, Straits Settlements.
Tattersfield, George H., 20, Kenilworth-court, Putney, S.W.
Thanewala, Maneck K., 438, Thakoredwar, Bombay, India.
Thomas, R. G. D., 8, Mission-row, Calcutta, India.
Tremlett, Washington, 13, Rue Auber, Paris, and 41, Conduit-street, W.
Venn, John Augustus, Onitsha, Southern Nigeria, West Africa.
Wang Tahsieh, His Excellency, 2, Lancaster-place, Belsize-square, N.W.
Watson, Professor William Franklin, A.M., Furman University, Greenville, South Carolina, U.S.A.
Welchman, Mrs. B. de Vere, The Close, Exeter.
Westwood, Ernest Herbert Wyndham, A.M.I.E.E., Orontes, 140, Barkly-street, St. Kilda, Melbourne, Australia.
Winstanley, Herbert, Beddington-lane, Beddington, Surrey.
Wood, Thomas A., Nairobi, British East Africa.
Young Hee, M.R.S I., Kia Ora, 18, Kennedy-road, Hongkong, China.

The paper read was—

MECHANICAL FLIGHT.

By Eric Stuart Bruce, M.A., Oxon.

Otto Lilienthal, that gifted martyr of the air, tells us that in flying machines conception is nothing, construction is little, experiment is everything.

The year of 1908 will be memorable in aeronautical science for its demonstration of the possibility of mechanical flight. Day after day in France and America has been seen the spectacle of men, not holding in their hands an elaborate plan, not standing by some huge winged machine, but flying in the air with a grace equal to that of the soaring bird. This has been done with a machine not raised by the buoyancy of a gas, but with one that is heavier than the medium in which it travels, and whose sustentation and direction is accomplished by dexterity and skill.

The experiments of the Brothers Wright are new triumphs of the intellect of man, new examples of the old truths that a difficulty is a thing to be overcome, and that the impossibility of to-day may be the achievement of to-morrow. This progress in human flight is not the result of any sudden new discovery; it is the sequence of a long series of experiments. Nor is it one nation that has forged the links that connect past researches to the successful issues of the present year. Internationalism has been one of the most striking features of aeronautical development.

It is, however, not without honour to the British nation, that one of the fundamental principles of the recent experiments was proposed and elucidated by a Briton in 1866. I refer to the important principle of superposed surfaces, advanced in that year by the late F. H. Wenham. He pointed out that the large monosurfaces necessary to carry a man are difficult of control, but that the lifting power of such a surface can be obtained by placing a number of small surfaces above each other. Wenham built flying machines on this principle, with appliances for the use of his own muscular power. He obtained valuable results as to the driving power of his superposed surfaces, but he did not accomplish flight.

It was in 1872 that H. von Helmholtz emphasised the improbability that man would ever be able to drive a flying machine with his own muscular exertions. After his statements there came a period of stagnation in aeronautical research. An all important link was then wanting: this was the light motor.

It is difficult to say how much aeronautical science owes to two illustrious names—Sir Hiram Maxim and the late Professor Langley. These two eminent men took up the subject of flight about the same time in the last decade of the last century, and applied to it all the scientific knowledge of the time. The flying machine had come to be associated in the public mind with foolhardiness and failure. In the discussion following Sir Hiram Maxim's paper, "Experiments in Aeronautics," read before this Society on November 28th, 1894, he says, "at the time he took up this subject it was almost considered a disgrace for anyone to think of it, it was quite out of the question practically." But these two scientific men stepped into the breach, rescued aeronautics from a fallen position, and fired in its cause the enthusiasm of men of light and leading.

Sir Hiram Maxim built the largest flying machine that has been constructed. It spread 4,000 square feet of supporting surface, and weighed 8,000 lbs. The screw

propellers were no less than 17 feet 11 inches in diameter, the width of the blade at the tip being 5 feet The boiler was 363 h.-p. The machine was run upon wheels on a railway line. It was restrained from premature flight by two wooden rails placed on each side above the wheels. But on one occasion the tendency to rise proved too strong for these measures of restraint. The machine burst through the wooden rails and flew for 300 feet. But Sir Hiram Maxim was not ready at that moment to fly further. When the machine took flight steam was shut off, the machine alighted, and was damaged in the fall. The wisdom of Sir Hiram Maxim in not allowing the great machine to take free flights was most commendable, for at that time the problem of the maintenance of equilibrium and stability was quite unsolved. But what could not be dared with a gigantic machine carrying human passengers, could be dared with an unmanned model. In 1896 Langley's tandem-surfaced model aerodrome had luck with the aerial currents, and flew for more than three-quarters of a mile over the Potomac River. This machine had 70 square feet supporting surface, weighed 72 lbs., and had an engine of one-horse power, weighing 7 lbs. It is well known how in later years, Langley exaggerated his model into a machine which carried a man, and how twice when it was about to be put to the test over water, at the very moment of being launched, it caught in the launching ways and was pulled into the water. It is supposed that grief at not being able to put his work to a practical test hastened his death. But it is doubtful whether Langley's man-lifting aerodrome would have kept its balance had it escaped the clutches of the launching apparatus. In the light of recent experiments it has been seen that the maintenance of equlibrium and stability demands special contrivances.

It was the question of equilibrium which first led Lilienthal in Germany to experiment with what are called gliding machines. These are aeroplanes which are launched from some hillside against the wind, and depend upon gravity for their motive power. In this way the art of balancing can be practised on motorless gliders. With Lilienthal commenced the age of systematic experimental flight. It was Lilienthal who made the great discovery of the driving forward of arched surfaces against the wind. Lilienthal made some 2,000 glides. Sometimes from a height of 30 metres he glided 300 metres.

The underlying principle of maintaining equilibrium in the air has been recognised to be that the centre of pressure should at all times be on the same vertical line as the centre of gravity due to the weight of the apparatus. Lilienthal sought to keep his balance by altering the position of his centre of gravity by movements of his body. But one day he was upset by a side gust and was killed. Pilcher in England took up his epoch-making work. With his soaring machines he made some hundred glides, but he also made one too many. One day, in 1899, in attempting to soar from level ground by being towed by horses, his machine broke and he fell to the ground. He died shortly afterwards and became a British martyr of the air. It is sad to relate these successive tragedies, but recent accomplishment has fully justified the actions of those who gave their lives for the sake of knowledge and progress.

The experiments of Mr. Octave Chanute, from 1896-1902, form important links in experimental flight. He first introduced the vital principle of making surfaces movable instead of the aviator, and he made use of superposed surfaces. Mr. Chanute had made an exhaustive study of the subject of aerial navigation, evidenced in his book "Progress in Flying Machines." He estimated aright the value of the researches of Wenham, whose original memoir on superposed surfaces he has described as "classical." He did not hesitate to adopt the principles advocated by Wenham in his own practical machines. He thus afforded an example of the expediency of studying the past as well as the present. As the earth contains hidden treasures unexcavated for centuries, but which from their intrinsic beauty eclipse the decadent specimens of modern handicraft, so, too, the annals of science contain hidden treasures—indispensable principles—which after years of oblivion have to be unearthed into the light of day.

In his multiple-winged machine Mr. Chanute fixed the wings on pivots. They retro-acted and swung horizontally, so as to bring the centre of pressure to coincide with a vertical line passing through the centre of gravity. After making 300 glides with this, he made a double-decked machine. It consisted of a rectangular bridge truss of wood, braced by steel wires, and carrying aerocurve surfaces arched 1-12th on the top and bottom booms. An important feature was the rudder in the rear; it was attached to the

machine by an elastic arrangement. The upper and lower surfaces of this rudder were acted upon by the wind gusts, and altered the angle of incidence of the main supporting surfaces. Seven hundred glides were made by Mr. Chanute's assistants with this machine, without any accident. In 1902, Mr. Chanute devised a triple-decked machine, and in this, the surfaces were pivoted to rock, fore and aft, on a stationary pivot.

The work of Mr. Chanute represents important stages in the evolution of the flying machine, but it was reserved to two other geniuses to bring human flight to a point of progress where the prejudiced critic would be for ever silenced These two geniuses, were the Brothers Wright. I will, therefore, speak of their work, beginning with their earliest experiments.

Before essaying practical flight, the Brothers Wright carried out laboratory experiments. It was in 1900 that they first began to experiment with gliding machines at Kitty Hawk, North Carolina. With the comparatively small surfaces (15·3 square metres) they used in that year, they endeavoured to raise the machine by the wind like a kite, but finding that it often blew too strongly for such a system to be practical, in 1901 they abandoned the idea and resorted to gliding flight.

These machines of 1901 had two superposed surfaces, 1·73 metres apart, each being 6·7 metres from tip to tip, 2·13 metres wide, and arched 1-19th. The total supporting surface was 27 square metres. They dispensed with the tail which previous experimenters had considered necessary. Instead they introduced into their machine two vital principles, upon which not only the success of their preliminary gliding experiments has depended, but also their recent ones with their motor-driven aeroplanes: 1. The hinged horizontal rudder in front for controlling the vertical movements of the machine. 2. The warping or flexing of one wing or the other for steering to right or left. Later a vertical rudder was also added for horizontal steering. The combined movements of these devices maintained equilibrium. The importance of the system of torsion of the main carrying surfaces cannot well be over-estimated. We have only to look to nature for its *raison d'être*.

An instantaneous photograph of a flight of sea-gulls shows how varied are the flexings of nature's aeroplanes in their wondrous manœuvrings to maintain and recover equilibrium.

In the earliest machines of the brothers Wright the flexing was attained by light strings held in the hands of the operator. It will be seen later how in their recent machines a lever controls this as other accessory movements. The frame of the 1901 machine was of spruce wood and steel. With this machine about 100 glides were made from sand mounds, known as the Kill Devil Hills, at angles of 9-10°. A feature of those early experiments was the placing of the operator prone upon the gliding machine, instead of in an upright position, to secure greater safety in alighting, and to diminish the resistance. This, however, was only a temporary expedient while the Wrights were feeling their way. In the motor-driven aeroplanes the navigator and his companion are comfortably seated. After the experiments of 1901, the Wrights carried on laboratory researches to determine the amount and direction of the pressures produced by the wind upon planes and arched surfaces exposed at various angles of incidence. They discovered that the tables of the air pressures which had been in use were incorrect. Upon the results of these experiments they produced in 1902 a new and larger machine. This had 28·44 square metres of sustaining surfaces. Thus they showed they had attained to the use of surfaces of twice the area that previous experimenters had dared to handle.

An insight into the cautious and scientific methods by which the Wrights have reached their ultimate success is afforded by the tests which this new machine underwent before gliding flight was undertaken with it. The machine was first flown as a kite so that it might be ascertained whether it would soar in a wind having an upward trend of a trifle over seven degrees. This was the slope of a hill over which the current was flowing. An experiment showed that the machine would soar under these circumstances whenever the wind was of sufficient force to keep the angle of incidence between four and eight degrees. Hundreds of successful glides were afterwards made along the full length of this slope, the longest being 22½ feet and the time 26 seconds. Glides were made at angles of descent of six degrees to seven degrees, and the glider supported 66 kilogrammes per horse-power.

The next step was to apply a motor and screw propellers in place of gravity. This was done in 1903, when four flights were made, the first lasting 12 seconds, the last 59 seconds, when 260 metres were covered at a height of two metres.

In 1904, several hundred flights were made, some being circular. All this work was carried on in a secluded spot and unpublished.

In December, 1905, the world was startled by the news that the Brothers Wright had flown for 24¼ miles in half-an-hour. Much more than this at the time the brothers would not say, and for three years the world thirsted for the fuller knowledge only this year revealed. In the interval some went so far as to distrust the statements of the Brothers Wright, but those who, like myself, had had the privilege of correspondence with them from their first experiments felt the fullest confidence that every statement they had made was fact. This summer at Le Mans in France and Fort Myers in America, Mr. Wilbur Wright and Mr. Orville Wright have demonstrated to the world the veracity of their former statements. The photograph shown to the meeting is the machine at Le Mans with which Mr. Wilbur Wright won the world's record of flight—1 hour 31 minutes 25 4-5 seconds. This event was only two days after the news had arrived of the accident to his brother's machine in America in which Mr. Orville Wright broke his leg and Lieut. Selfridge was killed. This accident, of necessity, caused a temporary depression. I can myself bear witness to its momentarily depressive effect on an illustrious aeronautical assemblage. Had there not been the brother at Le Mans to vindicate the good character of the Wright machine, the disaster might have been another of those blows which retard progress. The accomplishment of Mr. Wilbur Wright's great feat at a time when his nerves must have received a severe shock was an example of the competency of the two geniuses who, of all aviators, have most forwarded aerial navigation.

In Wilbur Wright's machine at Le Mans, the two superposed slightly concave surfaces are about 12·50 metres long and 2 metres wide. They are separated by a distance of 1·80 metres. At a distance of 3 metres from the main supporting surfaces is the horizontal rudder for controlling the vertical motions. This is composed of two oval superposed planes. At 2·50 metres in front of the main supporting surfaces is the vertical rudder, composed of two vertical planes.

The 25 horse-power motor is placed on the lower aero-surface. This weighs 90 kilogrammes. There is no carburetter, the petrol being injected into airlet pipes. At the left of this motor are the two seats, side by side, for the operator and his companion.

The transmission of power to the two propeller shafts is effected by chains running in guide tubes. The left-hand chain is crossed, to give the opposite movement to the propellers. The two wooden propellers at the back of the machine are 2·50 metres in diameter. They have a low rate of revolution—450 revolutions per minute. Perhaps the weakest part of the Wright machine is the material of the propellers—this is wood. To this fact would appear to be due the accident to Mr. Orville Wright's machine, in America. As is well known, Mr. Orville Wright had extended the length of those propellers. In rotating, one of them struck against a wire, hanging loosely, and was broken. Had the propeller been made of suitable metal, it would not, probably, have been injured by the impact.

The area of the sustaining surfaces is fifty square metres. The weight of the whole machine (with aviator) is about 450 kilogrammes. Levers under the control of the aviator regulate the various functions of the machine, the flexing of the carrying surfaces, the movements of the horizontal rudders, the vertical rudder, &c.

For starting, the machine runs on rollers along a single wooden rail, but when there is no wind the catapult apparatus has often been used. This consists of a skeleton pylon stand, at the top of which there is a weight attached to a cord passing through a pulley. The free end of the cord is passed through a pulley at the remote end of the line and brought back and attached to the car by a patent catch. When the weight is allowed to fall the machine is shot forward with starting impetus, enabling the flight to commence. The weight is 700 kilos, and it falls 5 metres.

While the world was waiting for the details of the Wright's machine, another type of aeroplane machine came into existence in France, which may be described as an unbending type, and is devoid of the vital principle of movable main surfaces, which would appear to give the Wright machine a great margin of safety in windy weather. The first of these machines was the bird of prey of M. Santos Dumont. Rudely simple was it in its construction. Two box kites form the supporting surface. In the centre is the motor with the screw behind. To attain flight the machine is run upon wheels until a certain speed is attained, when the

machine takes flight. Mr. Farman's machine is another example of a machine that does not bend its wings to adapt itself to circumstances, but still we are bound to confess that the feats which Mr. Farman has managed to perform with his machine, which many critics will say is a less perfect type than that of the Brothers Wright, are greatly to his credit. Our national sympathies have been very much with Mr. Farman in his experiments, for though they have taken place in France, the experimenter is of British descent.

Amongst the more recent feats of Mr. Farman may be mentioned his town to town journey from Chalons to Rheims. Another example of the same school is M. Delagrange's aeroplane, and this has accomplished no unworthy flights. In fact, at one time, this last summer, M. Delagrange held the officially observed record for duration of flight, 29 minutes $53\frac{1}{5}$ seconds, until this was greatly surpassed by Mr. Orville Wright.

In practical aeroplane travelling there are two great difficulties to be overcome: one, starting; two, stopping in the air. As has been mentioned above, there are at the present time two methods of starting employed, that of the Brothers Wright, who use starting appliances that are independent of the machine, the other that of the French school, who use wheels which are part of the machine itself. There are disadvantages with either method. It would be hardly practical to carry a huge starting catapult, or even rails, on an aeroplane, and the system of running on the ground on wheels to start, would not be practical in a ploughed field, while the speed required would be prohibited on a public road. For this reason, some think that the Helicoptère, or lifting-screw flying machine, will have advantages over the aeroplane, as the lifting horizontal screws will enable it to rise from any place at any time, and will also endow it with the power of stopping horizontal motion, without descending.

Possibly the future flying machine will consist in the combination of the aeroplane and lifting-screw systems. In the way of safety there will be undoubtedly an advantage in retaining the aeroplane surface in case of falls, even though it may not be adjusted to support a certain weight, like a parachute. In the case of Mr. Orville Wright's accident, the spread of canvas, to some extent, retarded the fall. In the opinion of Mr. Orville Wright, had the accident happened higher up in the air, he would have been able to right the machine, and to glide safely to earth with it. When I send up this tiny aeroplane, made on the Dandrieux pattern, after its power is exhausted it glides down, sustained by its aeroplane alone.

Concerning the fall of an aeroplane through accident, such as the collapse of a motor, or even the gliding down purposely without motor action when near to ground, I would like to make a suggestion. If arrangements could be devised suddenly to make the sustaining surfaces convex when about to descend, a safe descent would probably be much facilitated. When I take a flat strip of paper and let it fall, in the majority of cases it will fall revolving rapidly, a fact first pointed out by Maxwell and afterwards commented upon by Lord Rayleigh as a fact that has not been completely explained. But if I curve up the ends of this strip very slightly, the strip generally falls to the floor without turning over. If I let the strip fall ten times in succession, it will probably maintain its stability throughout the test. This is, I think, an experiment worth a practical test.

While on the question of means of securing safety, it may perhaps be suggested that in experimental flights it would be advisable if the operator and his companions provided themselves with parachutes, which probably in the future will come to be regarded as the lifebuoys of flying machines. It would be posssible for parachutes to be so suspended that the weight of the aviators suddenly thrown on to them would release them. Probably the best form of parachute will be found to be one with a rotary fall, a principle that has yet to be worked out.

The sycamore seed in falling affords an example of a rotary parachute. I let these sycamore seeds fall from a height and they descend slowly and steadily, rotating as they fall. It seems, therefore, that for a small surface the rotary fall is slower and more stable than gliding falls. But the behaviour of large surfaces has yet to be observed.

There are some who say that the experiments of the Brothers Wright show that the conquest of the air is complete. But those who speak thus, grasp not the situation. It is true that the Brothers Wright have, this year, shown that mechanical flight is possible in a calm atmosphere, and in slight breezes, and this is in itself a triumph. But before we can say that man has mastered the great problem of flight, he must fly not only in tranquil airs and

slight breezes, but against strong winds and treacherous gusts. Then only will he have wrested from the sea gulls their long-guarded secret, when, like them, he can use the swift moving air currents to aid his flight. When the aeroplane has encountered the storm, and sailed in its midst undisturbed, and come back safe to port, then, and then only, can we say that, for everyday practical use, the aeroplane has come.

There will, too, be much to be learnt concerning the tricks and ways of aerial currents, even in more tranquil airs. The following simple experiment may suggest how the balance of an aeroplane may be unexpectedly upset by an uprising current of air.

When the wind blows against a cliff or steep hill there is produced an upward current of air. You can see this by watching sailing birds who, with outstretched wings, rise up, sustained by these vertically moving currents. Imagine this board is the side of the cliff or hill, and that air pressure derived from these bellows is the wind. On the top of the board I have placed a little piece of tissue paper. I blow against the bottom of the board and send the little piece of paper flying by means of the up-rising currents of air produced.

Now imagine an aeroplane comfortably travelling and maintaining its equilibrium and stability. When it reaches the region of the cliff and the sudden uprising current, there will be a great chance of its equilibrium or stability being upset.

In view of the possibility of man acquiring, like soaring birds, the power of making use of the vertical component of the wind, the internal work of the wind, *i.e.*, its gustiness, and even the non-uniformity of wind, *i.e.*, its different velocities at different levels, it would seem important that every light that can be thrown upon the difficult subject of equilibrium and stability, experimentally and mathematically, should be eagerly sought. In connection with the subject of "longititudinal stability," I should like to call special attention to the remarkable researches of Professor G. H. Bryan and Mr. W. E. Williams.

In the course of a few remarks on gliding flight which Professor Bryan made during a Friday evening discourse at the Royal Institution in 1901, it seemed to me evident that he had a greater grasp of the mathematical side of the problem of aerial navigation than had been previously evidenced, and, at my request, he wrote the remarkable mathematical discourse on the subject which was read before the Aeronautical Society of Great Britain on December 3rd, 1903.

The remarks of Professor Bryan as to the distinction between equilibrium and stability—a distinction not very generally appreciated—may perhaps with advantage be here qnoted:

"We say that the motion of a flying machine is steady when the resultant velocity is constant in direction and magnitude, and when the angle of the machine to the horizontal is constant. If this motion is slightly disturbed the machine may either return after a time to the original motion, or it may take up a new and altogether different mode of motion. In the first case, the steady motion is said to be stable, and in the second unstable.

"It is evidently necessary for steady motion of any kind that there should be equilibrium—*i.e.*, that there should be no forces acting on the machine (apart from accidental disturbances) which tend to vary the motion, and hence it follows that the number of modes of steady motion of which a machine is capable is, in general, limited, and that when an unstable, steady motion is disturbed, the new mode of motion taken up is entirely different from the old.

"It is necessary to distinguish carefully between equilibrium and stability, as the two are very often confused together. Equilibrium is necessary to secure the existence of a mode of steady motion, but is not sufficient to ensure the stability of the motion.

"The question of the stability of a rigid body moving under the action of any forces has been solved by Routh. In order to apply his results to the stability of flying machines, it is necessary to know the moment of inertia of the machine about its centre of gravity, the resistance of the air on the supporting surfaces as a function of the velocity and angle of incidence, and also the point of application of this force, *i.e.*, the centre of pressure for different angles of incidence. If these are known for the surfaces constituting any machine, then the problem of its stability for small oscillations can be completely solved. Unfortunately, our knowledge of these points is very unsatisfactory. Several valuable series of experiments have been made to determine the resistance on planes, but there is still some doubt as to the position of the centre of pressure at small angles of incidence, especially for oblong planes, and very little indeed is known as to the movement of the centre of pressure on concave surfaces. Until experiments are made on this point it will be impossible to solve the problem of stability for machines supported on concave surfaces."

The last words of Professor Bryan emphasise the necessity of laboratory research, as well as the need for continuing our experiments in the open. Regarding experiments as to the movement of the centre of pressure on concave surfaces, it may be hoped that when the Brothers Wright publish the full results

of their own laboratory researches, light on this subject will be forthcoming.

The photographs of the paths of aerial gliders taken by Professor Bryan and Mr. W. E. Williams are suggestive of the utility of further photographic research on a larger scale. These photographs were taken by attaching magnesium wire to small gliders, consisting of square planes and pairs of square planes, and allowing them to descend in front of a camera in a dark room with the wire burning. By placing a rotating wheel in front of the camera, a dotted instead of a continuous track was obtained, enabling the velocities at different points to be compared. When the path is nearly straight two sets of oscillations are observed. If either of these oscillations increases as the glider descends, the glider will be longitudinally unstable.

The following are the photographs referred to:—

1. Single square plane. Length of path about 3 yards.

2. Path of glider. Single plane. The curve shown is the projection of a helix.

3. Path of glider. Two square planes at a small angle showing instability due to increase of oscillation of small period.

4. Path of glider. Two square planes inclined at a small angle.

5. Path of glider. Two square planes at a small angle. The oscillations of short period were not started in this case. Length of path about 8 yards.

6. Two square planes.

7. Path of glider, consisting of two square planes set at an angle of 15°. Length of path about seven yards. The drop at left-handed side was caused by glider hitting a bench.

8. Path of glider, consisting of two square planes inclined at an angle of 10°.

9. Two square planes at angle, gliding at a large angle with the horizontal.

10. Single square planes.

11. Path of single square plane, showing instability. Interruptions in the curve were caused by a wheel rotating in front of lens of camera, and show relative velocity at different points of path.

With regard to the equilibrium and stability problem, we have not yet got quite beyond the utility of observations with gliding models in the open. There is much yet that might be learnt as to the behaviour of various forms of sustaining surfaces. An instance of very successful and instructive glides (with models) was afforded on the occasion of the Kite Display, at Sunningdale, in 1907, the experimenter being Mr. José Weiss. His demonstration of the possibility of the maintenance of balance for a considerable distance, with a model launched from a hill top, was one that should encourage himself and others in further research into the difficult problems of soaring flight. He exhibited two model gliders, having wing areas of 3·6 and 12·8 square feet, with total weights of 2½ lbs. and 15 lbs. respectively, the lead ballast in each case representing about two-thirds of the total weight. When launched from the highest hillock available, the best glides obtained were some 200 yards in length, with drops of from thirty to fifty feet. The small model raised some 200 feet by a large kite, and released from that height, righted itself instantly in each case, and gave some very fine glides, the longest being about 600 yards. Some further comparative tests of this description might prove useful. Professor Bryan has suggested that model flying machines might advantageously be fitted with instruments to register stability.

In connection with aerial navigation, a line of research the importance of which cannot well be overestimated, are those investigations which deal with the motions of the medium of travel. Thanks to the indefatigable efforts of Dr. William Napier Shaw, the investigation of the upper air is forming a feature of the work of the Meteorological Office, and most important results have been obtained. Such investigations are all-essential for the progress of meteorology; but they are equally important for the advance of aerial navigation, and their continuance and extension is worthy of the heartiest national support.

It has been said that the ideal flying machine will be attained by a system of automatic stability. Since Mr. Brennan showed how a train could travel on a mono-rail and keep its stability by the application of the gyroscope, a new hope has arisen that the gyroscopic principle may be so applied to flying machines as to render them automatically stable. Simple experiments with the ordinary gyroscopic top show us that rotary motion can annul the effects of forces other than gravity. I will show a most simple experiment I have devised as being suggestive of the gyroscopic principle being able to annul the disturbing influences of air currents if applied to flying machines

I spin this gyroscopic top on the point of this piece of wire projecting from a wooden stand. When spinning in this position, to the uninitiated it might seem that the top is in a very unstable position, and that the slightest force would turn it over. But I can subject the top while spinning to the strong air pressures produced by the action of these bellows, and its spinning is quite undisturbed, the rotary action annulling not only gravity but the force of air pressure also. The possibility of the application of the gyroscope to flight is worthy of the attention of the engineer.

Though we are yet in a stage of experimental flight, and much has to be learnt in theory and practice before it can be adapted to the requirements of daily life, still even in its partially developed state the aeroplane may prove to be a potent factor of war. Under the cogent force of necessity the slenderest threads may have a power that in peace and prosperity would never be accorded them.

Who would have thought that during the siege of Paris a few unsteerable balloons could carry on the postal service? If war were to break out might not a clever and nimble nation recognise powers of mischief in the multiplication of a Wright aeroplane?

For this reason it is imperative that the British nation should keep its national service of the air at the same standard as other nations.

Such progress in aeronautics as has this year been chronicled is perhaps the fore-shadowing of that day when the first line of defence will be common to all nations. For long our insular position has been our security and our ships our glory.

But there is an universal law, "πάντα ῥεῖ," "nothing stands." If the air is conquered, whether we like it or not, the skill of the British engineer must be largely diverted from traversing the watery ocean to raising defences in the air. But there is consolation in the thought that the maintenance of our supremacy in the air will call for those heroic qualities which sometimes in security have to lie dormant, but which are necessary to preserve nations from decay.

I will forbear the discussion of the much vexed question as to whether, when frontiers are obliterated and war made hideously terrible by the flying machine, there will come the end of strife. But at any rate we may hope that the common paths of the air that will unite nations will remove many prejudices and prolong the blest hours of peace.

DISCUSSION.

The CHAIRMAN, in opening the discussion, thought that if the audience turned aside from the alluring statements of the last few paragraphs of the paper and confined themselves to the present instead of looking so far into the future as to discuss the effect upon war, and upon nations which engaged in war, of the perfecting of the flying machine, they would recognise that a long struggle had been going on between the air-ship and the aeroplane, the dirigible balloon and the heavier-than-air machine, which was kept in the air by its velocity or by some effect of screw rotation. He supposed the issue between the air-ship and the aeroplane would probably depend upon the way in which those machines managed to accommodate themselves to the weather. It was certain that a machine which was of the size of an Atlantic liner presented opportunities to the weather of which it was never shy of taking advantage. The enormous size that was necessary for an air-ship laid it open to difficulties to which, up to the present, nearly all air-ships had had to succumb. Aeroplanes also were machines of very considerable dimensions. Perhaps the most beautiful slide which had been shown was the one representing the flight of seagulls. Those ingenious birds managed to take advantage of the weather in a way which at present was inimitable by human devices, possibly on account of the very large dimensions that were necessary in order to overcome the great forces of gravity. It therefore became necessary to treat the relation of the aeroplane to the atmosphere in a way in which it had not hitherto been studied. As soon as the form of aeroplane which was most likely to be successful had been settled, additional information would be demanded as to the structure of the winds, because, when the aeroplane had been adapted to windless air or a light breeze, it would be necessary to make the next move and adjust it to stronger airs. Something was already known about the variations in the velocity of the wind; but it was not known to what extent those variations in the current extended laterally or vertically. The effect of the obstacles that found themselves in the way of an air current in setting up eddies and variations in the structure of the atmospheric current, which were of the order of the dimensions of a flying machine, were not known to any great extent. Those were some of the subjects which quite properly might be thought about in connection with the author's admirable review of the magnificent success that had been achieved by the Wright Brothers, Mr. Farman, and others in the application of the flying machine.

Sir HIRAM MAXIM said it was quite true that he commenced to study the question of flying machines many years ago, but it was not until 1893 that he commenced serious experiments. As early as 1886 he was approached by several wealthy gentlemen,

who asked him if he thought he could build a flying machine, how long it would take, and how much it would cost? His reply was it would take five years of his undivided attention and might cost £100,000. A common domestic goose could fly and why should not man? He said that a very powerful and light motor would be necessary, and, as no such motor was in existence, he should devote three years of his time to developing a motor of the internal combustion type, and two years to building a true flying machine. As no suitable motor was in existence in 1893 he built a pair of very light steam engines, that weighed in a finished condition 320 lbs. each, and collectively they developed 362 actual horse-power. The screw propellers were 17 feet 11 inches in diameter and had a pitch of 16 feet. When running at full speed they developed a screw thrust of rather more than 2,200 lbs. The highest speed attained was at the rate of 42 miles an hour, and the lifting effect was about a tenth more than the weight of the machine, the water and three men on board. But the quantity of water required was so great as to render the machine of no value; moreover, it was found absolutely impossible at the time to obtain sufficient room for manœuvring the machine in the vicinity of London. During the two first years of his experimental work he was out of England fully fourteen months on company business. The ultimate form his machine took was the result of numerous experiments, and in its finished condition it had the following features:—Two superposed aeroplanes, fore and aft horizontal rudders, screw propulsion with two wooden screws running in opposite directions; the screws were strengthened by having canvas glued on to the thin parts of the blades; and it was interesting to note that the most successful machines built up to to-day had all of these features. A great deal had been said lately regarding the value of flexing the outer and after corners of the wings or aeroplanes of flying machines. That was one of the features, or perhaps the feature, of the Wright machine; but that device was patented by him in connection with a flying machine eleven years ago. He believed that it was in the reign of Queen Anne that a large cast-iron cannon was mounted at Dover Castle with some such inscription upon it as:—"Swab me out and keep me clean, and I'll send a ball to Calais-green." As a matter of fact, however, that gun would not carry more than one-tenth part of the distance across the Channel; and he doubted very much if it would be possible to-day to construct a gun powerful enough to carry much farther than half way across the Channel. Up to the present moment the only apparatus produced by mankind that conld carry on warfare across the British Channel was a flying machine. The Wright machine, as Major Baden-Powell would be able to testify, was a very rough and imperfect piece of mechanism. The home-made motor of the Wright Brothers worked very badly, and on many occasions it would only work a few minutes at a time without a failure, and the machine itself was susceptible of a great number of improvements. Still, the machine, imperfect as it was, flew, and it was known that on one occasion it continued in the air over an hour and a half, and travelled at the rate of forty miles an hour. It would therefore be seen that, with a machine no larger and no more efficient than that, providing it had a reliable motor, it would be possible to cross and re-cross the Channel three times in the darkness of one night. The Wright machine has two aeroplanes, each 40 feet long. The motor was of 24 horse-power, but still Wright was able to carry a load in addition to his own weight of 240 lbs. The engine has four cylinders and a rather heavy cast iron fly-wheel; the weight of the fly-wheel would easily add two cylinders to the motor when no fly-wheel would be necessary. With this additional power and a slight addition to the length of his aeroplanes, he would be able to carry easily a weight of 300 lbs. at a rate of forty-five miles an hour. It would, therefore, be seen that the Wright machine, with only a very little improvement would be a very efficient military weapon. Did anyone doubt for a single moment that in case the country found itself at war with a strong Continental Power, such machines would not be used for bombarding English towns from the Continent? A French engineer, who was in a position to know, and who had a thorough grasp of the subject, informed him only a short time ago that, within one year, machines would be made in France that would fly from Paris to London, without stopping. Such machines were certainly in range of the "possible," and when they came, London could be attacked without encountering the dreaded British Navy. There was only one means of combating that danger, viz., to make flying machines ourselves. The discovery of gunpowder made a complete change in civilised warfare, but the change did not take place quickly, because guns at that time were very difficult to make with the tools and appliances in existence. But, at the present moment, the tools and appliances were at hand, and the change would be quite as radical, and a great deal quicker than it was on the discovery of gunpowder. Vast sums of money would be paid by Governments, in the immediate future, for military flying machines, and an opportunity was now presented to wealthy men, such as only occurred once in a century. But imagination was necessary in order to look into the immediate future. He had been working on drawings relating to flying machines during the last three weeks. One of the first things he took in hand was a carburetter, and he had designed one that would make gas, or rather carburetted air, from light petroleum of a uniform density quite irrespective of the quantity used or the temperature; it would make gas of the same quality whether the pressure was one ounce or 100 lbs. to the square inch on the liquid. With this apparatus a gasoline motor ought to work as well and be as reliable as the ordinary gas motor using town gas. He had recently made drawings of an extremely light and powerful motor which would be much lighter

for the power developed than any motor heretofore made, and still have a fair factor of safety. That was accomplished by using an especially strong steel, and putting it where it would do the most good. It appeared to him that it would be a relatively simple matter to build successful flying machines at the present moment, and a great deal of experimenting was not necessary. Stability against tipping over and plunging sideways could be provided against without flexing wings that required a great deal of skill to work. It was only necessary so to poise the side wings or aeroplanes as to cause them to encounter more air and to produce greater lifting effect when tilted downward, *i.e.*, to arrange the wings so that in case the machine tipped to the right or to the left, the outer ends of the aeroplanes produced a greater lifting effect on the lower side than on the higher side. That made the apparatus self-balancing in that direction, and consequently no skill was required; and as far as steering in a vertical direction was concerned, to provide against rapid rearing or pluuging, it was only necessary to commence experimenting with machines in which the fore and aft rudders were widely separated. That gives the operator time to think and act. He had recently prepared a little work on flying machines, in which he gave an account of his experimental work, and a considerable amount of data and formulae that would be of great use to those who were experimenting with flying machines. It had about 100 illustrations, and nearly all the photographs and drawings were made by himself. He expected it would be published within a week, and he hoped it would do something to popularise the science of aerial navigation. He was no longer a young man, but a very active old man, still able to do an immense amount of work, and he was ready to put his shoulder to the wheel and do his level best to put this country at least abreast of any other country in the new science.

Major B. F. S. Baden-Powell thought all present must have enjoyed Mr. Bruce's paper, which gave an excellent *resumé* of the recent advances in the conquest of the air. Sir Hiram Maxim had made a remark with regard to his (Major Baden-Powell's) opinion of the Wrights' flying machine. It was true that when he first examined it he was very much struck at the rough way in which it appeared to be put together, yet it was impossible to find any part that was really weak and incapable of fulfilling its object, so that it was a thoroughly good machine, although it certainly looked rough. Some people said that the Wright machine looked uncomfortable and dangerous, and that it pitched about, but having had the opportunity of riding in it, he was able to say that he felt just as safe sitting in the machine as he did in sitting on one of the seats in the theatre in which the meeting was being held. All who wished to see how the Wrights' flying machine worked when it was in the air should attend the paper at the Society on the 9th inst., when a cinematograph film of the Wrights' machine which had been lent by Mr. Urban, would be shown; and, in his opinion, after seeing the film on the screen, it gave quite the best idea of the machine he had yet come across. Every motion of the machine was depicted, and the film gave a very good idea of what the machine looked like when it was flying through the air. He wished to endorse Sir Hiram Maxim's remarks with regard to the great difficulty experienced with the engines of flying machines. If no such trouble had been experienced he, and no doubt many others, would long ago have built a machine that would easily fly through the air. He began experimenting with a small petrol engine many years ago, but he could never get it to work; and only that very morning he had been looking at an engine which he had had for eight months, and even now it did not run satisfactorily, although it was working much better than at first. Every day improvements were being made in the motors, and he did not think difficulties connected with motors were likely to largely interfere with flight in the future. He was convinced that, not in a lengthened time but within the next two or three years, probably all present would have experienced what it was like to fly through the air; and it was of the greatest importance to England from a military point of view that Englishmen should push ahead with the subject and develop it, as their neighbours had been showing them they ought to do.

Mr. Walter F. Reid thought that everything the author had stated bore the impress of truth; and all his statements could be absolutely relied on, particularly with regard to the Brothers Wright. There was a time when the Press of this country said that the Brothers Wright were romancing, and had not flown at all. He thought there was no doubt they had been maligned in that respect, and that they were really the first people to make a practical flight. The soaring work that had been done laid the foundation for aerial navigation in modern times, because unless one learnt to sustain oneself, and at the same time balance oneself in the air, there was very little chance of flying at all. Lilienthal left behind knowledge which had been applied by every maker of an aeroplane, and he was glad the author had paid a full tribute to his memory. He thought the greatest credit was also due to Mr. Chanute for the work he did with regard to the construction of aeroplanes, that gentleman practically constructing the first gliders of the two-decker system, such as were being used in most of the present aeroplanes. He saw a most interesting series of experiments made with a Chanute glider at St. Louis a few years ago, where a very simple starter was used. An electro-motor was fitted on a truck, the motor being connected with a steel drum on which was a steel wire. The man in charge sat on the ground about 100 yards or more away, the

motor was set going, it pulled him along, and in a second or two he was 40 or 50 feet up in the air. He then released the wire and sailed away. He had seen a number of models of lifting screws, but none of them, so far as he was aware, had actually been successful. Theoretically one would think they would work well, but practically, when one made screws of a size sufficient to bear a weight, especially of a person, structural difficulties commenced. The Aero Club had a private test of a number of models very recently. Some of them worked beautifully, but in most of them the proportion of the different parts was quite impossible on a large scale. With regard to the question of the rotary parachute, he did not understand how the parachute could sustain any greater weight through rotation, and he did not think it would. A surface whether it was rotating or not, had no motive power of its own; and if an unlucky aeronaut came down with such a rotary parachute, he (Mr. Reid) did not think he would know whether he came down on his head or feet! As far as meteorological work was concerned, he did not think the Government did its duty to the country. A magnificent meteorological station for exploring the upper air had been established in Germany, and in view of the enormous amount of capital that was invested in British shipping, this nation of all others ought to take the lead in the exploring of the upper currents of the air, because the upper currents predicted to a certain extent the lower ones. Another very important point was whether aeronauts should copy Nature or not. Most mechanical things were against Nature. So far as was known the largest flying organism that had ever existed had a spread of wings about 20 feet. That measurement had already been doubled on a flying machine, and if people were to fly they would have to go very much further in that direction. Very much greater weight for power was at the disposal of inventors than in any animal that existed. A machine could be obtained that exercised the power of a horse only weighing three or four pounds, and no animal or bird in Nature had such a relative power as that. He believed the screw was extremely defective, and he was not sure whether the screw, although it was so easily applied, would be the permanent means adopted for propelling aerial machines. Another important point was that the constructors of aeroplanes did not at present utilise the best constructive materials at their disposal, such as new kinds of steel; and he thought if co-operation could be established between metallurgical firms engaged in that industry and the makers of aeroplanes it would be a great national advantage.

Colonel F. C. TROLLOPE said that the chief fault of all aeroplanes was the engines, which were always liable to get out of order. He had heard from Sir Hiram Maxim that evening the best news he had heard for years, namely, that he had discovered a reliable carburetter. The prime necessity for an aeroplane was a trustworthy engine; but, unfortunately, those which had been hitherto used only worked for three or four minutes and then broke down.

Mr. PERCIVAL SPENCER thought the ideas promulgated in the early days of the Aeronautical Society had formed stepping stones to the accomplishment of flying, and having seen the Wrights' machine at Le Mans he was of opinion that the principles used in the construction of the machine were initiated years ago, and had now been developed to actual success. After calling attention to the ease with which the Wright aeroplane was manipulated and the marvellous records it had made, Mr. Spencer said he could not agree with the author that the wooden propeller was necessarily the cause of the accident to Wilbur Wright's machine in America, and, in his opinion, the same result would have occurred if the propeller had been made of metal. He also suggested that if Mr. Bruce repeated his lecture to an English audience he should convert the weights and measures he had mentioned into English figures, because otherwise an English audience might not appreciate the figures used. Personally he did not look upon the lifting screws associated with the aeroplane with any degree of confidence, and the author's suggested improvements in that direction were, he thought, hardly necessary. The Wrights had proved that they could fly 40 miles in one hour, and they therefore had a successful machine. Presuming that the English Channel was 20 miles across, Wright could have crossed the channel in half an hour, or with a 20 mile-an-hour wind blowing against him in one hour; or with a 20 mile-an-hour with him in 20 minutes. The French people seemed to understand that flying machines had come to stay, as they had ordered 20 machines and intended to allow expert aeronautists to practise with them. He trusted that this country would not be behindhand in this respect. A practical flying machine was at their beck and call, which the members of his own family would be prepared, if assistance was forthcoming, to use; and, thanks to Major Baden-Powell, this country was in the unique position of having placed at its disposal grounds near London where experiments on full-sized machines could be carried out.

Mr. BRUCE, in reply, said he believed the advantage of the rotary parachute was its stability and slower descent; but, as he mentioned in the paper, the experiment had not been worked out on a large scale. The fact that the propellers of the Wright machine were made of wood had been very much criticised on the Continent, and when an accident occurred he thought it ought to be thoroughly investigated, just as other accidents were, in order, if possible, to get at the cause.

The CHAIRMAN, in proposing a hearty vote of thanks to Mr. Bruce for his suggestive paper, thought that a great deal could be done by putting all those who were interested in the subject, in possession of

the latest information of what had been done by other countries and other persons, because there was a considerable danger of people trying over again experiments which had already been carried out, and from which conclusions had been drawn. The author had done that in a very excellent manner. Whatever might be said about the Wrights' machine, it could not be considered that the last word had been said about the construction of a flying machine, because we were at the beginning and not at the end of the subject. One of the ideas with regard to aeronautics which has blocked the way for some time was Prof. Newcomb's suggestion that the increase in difficulty was out of all proportion to the numerical increase in size, and that in the case of flying the increase of difficulty with size was at so great a ratio that a practical solution of the problem was not likely.

The resolution of thanks having been carried by acclamation, the meeting terminated.

LONDON TRAFFIC.

In August, 1907, a special London Traffic Branch of the Board of Trade was constituted, under the direction of Sir Herbert Jekyll, "with the object of considering new schemes of locomotion seeking statutory authority, so far as they come within the scope of the Board of Trade; collecting information; preparing an Annual Report on the whole subject of London Traffic for presentation to Parliament; and carrying out any additional duties that it might be called on to discharge." The first of these Annual Reports has just been published as a Blue Book [Cd. 4379], and it has been prepared with the object of supplementing the Report of the Royal Commission on London Traffic, which was completed in 1905, by indicating the changes which have taken place since then, bringing the statistics up to date, and giving any additional information that may have become available.

The Report proper is divided into eight sections. The preliminary part emphasises the magnitude and importance of the problem, which deals with an area of 116·9 square miles and a population of over seven millions. It would appear that not only is the population of London increasing rapidly, but also that the number of journeys per head is growing with even greater speed; for whereas in 1905 the number was 153·2, in 1907 it had risen to 177·5.

The second section deals with the cost of widening roads and streets, and the necessity for a comprehensive plan of street and road improvement. It is also pointed out that, although a good deal has already been done, the attention of the former Metropolitan Board of Works and the London County Council has been mainly directed to a number of isolated improvements "valuable in themselves, but having little relation to each other or to the general requirements of London as a whole." A couple of paragraphs are devoted to the question of constructing new roads for the exclusive use of motor vehicles; "but before allowing these to be made," says the Report, "it would be necessary to ascertain how far they would fit in with a general scheme; whether they would stand in the way of the opening of thoroughfares required for the common use of all kinds of traffic, and to what extent they would impede cross movement. This, however, pre-supposes the existence of a general scheme, and no such scheme has yet been made, or can be made, without full and detailed inquiry. The difficulty is one which arises whenever an attempt is made to pronounce upon the merits of any suggested improvement. It is clear that no real progress can be made until some definite plan has been evolved with which detailed proposals can be compared and co-ordinated."

Means of Locomotion.

The next four sections deal with public carriages, tramways, railways, and steamboats. During the years 1903-7, the number of licenses issued for hansom cabs has diminished from 7,499 to 5,952—a decrease of 1,547. In the case of four-wheeled horse-drawn cabs the number has remained about the same, while during this period the increase in the case of mechanical hackney carriages has been 722, of mechanical omnibuses 1,192, and of mechanical tramways 1,192. The year 1908 will probably show a further large increase of motor cabs, as the two principal motor-cab companies, which have now been amalgamated, expect to have 3,000 in service by the end of the year. Omnibuses showed a total increase of only 126; but the number of mechanically-propelled vehicles rose from 13 to 1,205. Tramcars increased from 1,719 to 2,172; and, whilst those drawn by horses declined from 1,143 to 404, mechanical power was used in 1,768 in 1907, as against 576 in 1903.

With regard to tramways, although the aggregate mileage is large—at the end of 1907 the total of tramways and light railways open for traffic in Greater London was 304 miles, and the total length of single track 553 miles—it is far smaller in proportion to population than the mileage in provincial cities, and compares even more unfavourably with that in foreign towns. But this is not the only defect in the tramway service. Diversity of ownership, lack of harmony in the working of different systems, want of connection or absence of arrangements for through bookings, are among the chief of these defects The Royal Commission passed severe strictures upon the inconveniences arising out of the conditions of the service. "From every point of view," they said, "tramway accommodation is glaringly defective . . . . It is difficult to appreciate how such a state of things can have been tolerated so long." Certainly considerable improvements have been made since these comments were written, but they are not wholly inapplicable now.

Some idea of the recent great activity in railway

construction in London is afforded by the fact that 26½ miles of new tube railways were opened during the period 1903-7, while the Metropolitan and District Railways, and various lines working in connection with them, were electrified. "These works . . . have had an effect on London traffic for which no parallel can be found since the introduction of railways. . . . More than 1,200 millions of passenger journeys were taken on electrical railways in the course of the five years from 1903 to 1907, and 70 millions more journeys were taken in 1907 than were taken in 1903. Traffic is still increasing, and the new lines have not yet had time to develop their full capacity."

The conclusion recapitulates the most important changes that have taken place since the issue of the Report of the Royal Commission, but adds that nothing of any moment has since occurred to weaken or disturb their recommendations. It then proceeds to refer to the unanimous recommendation of the Commission that a Traffic Board should be established, and sets forth a long list of the various enquiries which the Commissioners thought that it should undertake. The subject is, of course, enormous. As Sir Herbert Jekyll states, in his prefatory note, "London traffic presents not one, but a number of problems, differing from each other, yet so interrelated, that no one of them can be dealt with without at the same time bearing the others in mind. These problems which all involve social and economic considerations of great magnitude and intricacy, call for incessant vigilance, inasmuch as they are changing in some of their aspects from day to day, and a change in one is liable to affect all the others. A close study of the whole subject tends to support the conclusion that it can only be dealt with effectively by a permanent body giving continuous attention to it in all its branches. In any case, improvement must necessarily be slow, and might at first be scarcely perceptible. A large amount of preliminary work has to be done before a definite line of advance can be marked out, and a plan devised to which future action can be made to conform. Until that stage has been reached it is difficult to see how progress, adequate to the needs of its vast population, can be made in the orderly development of means of locomotion and transport throughout the area of Greater London."

THE DEVELOPMENT OF VENICE.

Venice is doing its best to emulate the enterprise of its citizens in the glorious past, when Venetian ships patrolled the Mediterranean from end to end. A line of 14-knot steamers is proposed to be run between Venice and Constantinople, while another line to South America and the Pacific Ocean is also being demanded. The Venice Steam Navigation Company has increased the aggregate tonnage of its ships, and a new steamer, the *Dandolo*, started for Calcutta last year. A regular call is now made at Massowah, and arrangements have been made with Japanese and German lines for the conveyance of Italian goods on from Calcutta to Japan and Australia.

A commercial museum, too, has been started for the special purpose of bringing the Venetian merchants into closer contact with firms in the East and elsewhere, and to promote the export of industrial and agricultural products from Venetia. The museum authorities publish a monthly journal giving reliable and most useful information relative to foreign markets, and Commendatore Ant. Santalena is starting exhibitions of Italian products at Smyrna and other commercial centres.

Direct trade between Venice and the United Kingdom developed during 1906, the imports having increased by £288,188 and the exports by £65,303. There is, however, far more energy, so we are told by the British Consul, shown by foreign firms, more especially German ones, in their methods of transacting business than is displayed by our countrymen. Their agents take much trouble in calling on all retail shops, and are glad to accept small orders. They can generally show samples of articles in demand which, though possibly inferior in quality, are of better outward appearance and cheaper, while they grant easier terms of payment, and quote prices including all charges to destination.

Among items of trade possessing interest for English business men it may be noted that typewriting has much increased during the last three or four years, notwithstanding the continued high prices of the machines, all of British or American origin. Gramophones, on the other hand, have lost their hold on the public favour, so the sale is now much limited. An increase again is observable in the number of shops for the sale of Venetian lace, which is in great demand. Real old lace is more rarely to be found, while any authentic piece of the sixteenth century, or *Point de Venise*, which had the reputation of being the finest lace in the world, is almost unobtainable except in museums, private families, or religious institutions. Lawn tennis and football clubs, which only a few years ago were hardly known in these provinces, are now greatly in vogue, and the Consul considers there is a good opportunity for British manufacturers to push the sale of goods connected with these games among respectable dealers in Venetia.

With regard to wine, viticulturists have successfully combated the peronospera and phylloxera by various methods. The crop in 1907 throughout Italy was estimated at 1,232 million gallons, a quantity never before reached; while in Venetia the yield was about double that of former years. Timber is a product which has been plentiful in past times; but the forests are deteriorating, especially in the province of Belluno, and re-afforestation is now an urgent reform in consequence of the floods so prevalent in

Venetia. Among the trees in great demand is the Canadian poplar, which has been found to be more suitable for manufacturing paper, and the Italian Government has offered a liberal scale of rewards with the view of promoting the planting of these trees.

Lastly, regarding some of the well-known monumental attractions of Venice, it is interesting to see that the rebuilding of the Campanile has been steadily progressing; about one-third or 105 feet has been completed, and the whole structure is expected to be finished by the end of 1910. The special scaffolding erected around the Campanile can be elevated or lowered by screws and levers at each corner, thus facilitating the reconstruction. The celebrated old prison of St. Mark, which, as all readers of "Childe Harold" know, is connected with the Palace of the Doges through the Bridge of Sighs, over the Rio della Pagha, will now cease to be a prison, and the prisoners are to be transferred to a more suitable building elsewhere.

POPPY CULTURE AND OPIUM MANUFACTURE IN INDIA.

Deep ploughing is practised for the poppy, which is not the case with any other crop grown in India; the same kind of plough is used now as was in vogue centuries ago. It is a rudely-constructed implement with one handle, a shaft, and the share beam. The last is usually made of the babal tree, because it is tough. A long pointed piece of iron is attached to the share beam to protect the wood, and to enable the plough to sink more deeply into the ground. This plough is drawn by two bullocks. The land is then harrowed, and it is ready for irrigation, which is accomplished by drawing water from a well, with two bullocks, and running it through a sluice to the land. The patch of land, from one-third to two-thirds of an acre, is surrounded by an embankment, which defines the boundary, holds the water for inundation, and serves as pathways. One well can be made to serve twenty to thirty farms of one "beegah," that is, one-third of an acre in extent. There are thousands of these wells throughout India used for irrigation in growing every kind of crop. They are comparatively cheap and convenient, as the farmers dig and equip the wells, and breed the bullocks themselves, so that well irrigation is the cheapest. Moreover, the Government can impose no tax for the water, as is done when it is supplied from Government tanks or reservoirs, or from canals. There are 25,500,000 acres of land in India irrigated by wells and private irrigation, according to the American Consul-General at Calcutta. The poppy seed is mixed with sand, so that it will not be sown too thickly, and one-third of the mixture is scattered over the prepared ground and the other two-thirds held for future sowing on the same soil. The farmer then gives the ground a watering. When the soil is dried out to some extent, he again ploughs the land, but not so deeply as at first, harrows, and then sows another third of the mixture of sand and poppy seed, which is treated as the first third. Then follows the sowing of the last third, and similar treatment. Three pounds of poppy seed will sow a "beegah." In a few days the seeds sprout and send up rich green shoots. Then comes the particular work of thinning out the sprouts. To accomplish this, the women and children crawl along much in the same way as is done in weeding and thinning sugar beets. In about thirteen weeks the fields are in a beautiful white bloom, for the white poppy is the one richest in opium, and women and children are set to work gathering the heads. They are carefully packed in baskets, and later made into "roties," which look like bread cakes, eight or ten poppy heads being baked in one cake. The cakes are reduced to powder and afterwards mixed with the liquid opium in the factory. When the crop of poppy heads is gathered, work begins in the opium "kothie," which is a shed made of bamboos and thatched with grass. The heads are punctured with four needles, tied in a bundle, and laid aside, for the juice to ooze out during the night. The juice thus obtained is carefully scooped up and preserved in an earthen jar. A poppy head will stand from five to six puncturings, which are made every other day, by which time the head has yielded all the juice that will ooze out. The heads are then broken off and the stalks made into bundles, for both the heads and stalks are sold to the Government. After the crop has been thus gathered and put into marketable shape, the Government officer comes into the neighbourhood, and sends word that he is ready to test, weigh, and pay for the opium produced. The old factory at Patna is one of the largest factories in Bengal, as well as one of the oldest. Here the crude opium is again tested, and then put into large vats which are slightly heated. Rakes are then used in stirring and in equalising the fluid preparatory to its being boiled, and the powdered pods put in to thicken it. When the mass is of the proper thickness it is taken out and put into earthen moulds, where it remains until it becomes quite hard. Then it is squeezed into the shape of balls the size of small apples. These balls are dried in the sun, and afterwards stored away in a room, on shelves one above the other. When it is ready to pack in chests, a native climbs from tier to tier, forty feet above the cement floor, and drops ball after ball in quick succession, these being caught by a native below, until all the shelves are empty. Near the opium factory is a saw mill, where the wood is cut in proper lengths and made into boxes. In these boxes the opium is packed for shipment and home consumption. The odour of opium arising from the factory can be detected a long way off, and a visitor to the factory will soon realize a sense of drowsiness, as if he had taken a dose of laudanum.

GOLD- AND SILVER-SMITHS' WORK.

An interesting exhibition of work in hand-beaten silver and gold, enamels, wrought-iron and architectural fittings was given last week by Messrs. Omar Ramsden and Alwyn Carr at St. Dunstan's Studio, Seymour-place, South Kensington. Among the most important exhibits were a number of rose-bowls. Of these perhaps the most interesting was a bowl in hand-beaten and *repoussé* silver, presented to the retiring Principal, Sir Arthur Rücker, F.R.S., by the staff of the University of London. This is emblazoned with the arms of the University, the impaled arms of Sir Arthur and Lady Rücker, and of Brasenose College, Oxford. These are connected by a ribbon bearing the dedicatory inscription, and alternating with panels in *repoussé* of the briar rose.

A pair of companion rose bowls was also shown, on which are depicted "The Revenge" and "The Armada." These display in rich *repoussé* a wealth of mediæval naval pageantry, and are good examples of fine silver chiseling. Another interesting side of these artists' work was the jewellery, amongst which was noticeable a finely chiselled gold St. George and the Dragon pendant.

A series of episcopal seals of the Lords Bishops of Carlisle, Exeter, Birmingham, Rockhampton and Polynesia deserve notice, especially the last. As Polynesia is a new diocese, it was necessary to design new arms. These show an heraldic ocean, bearing on its surface the St. George's Cross, upon which is laid a Bishop's mitre, to symbolise the foundation by the Church of England of a diocese amid the waves. The first quarter shows the arms of the archidiocese of New Zealand, in whose province Polynesia falls.

Messrs. Ramsden and Carr are fortunate in their opportunities, having been commissioned from time to time to design and carry out works of public interest. The Great Monstrance for Westminster Cathedral, and the Loving Cup for the University of Paris will be fresh in the memory of the artistic world. In their recent exhibition they showed a very handsome loving cup, presented to the Clothworkers' Company. A Gothic mustard-pot—one of fourteen executed for the Merchant Taylors' Company—is a work that takes rank with the beautiful mediæval salt-cellars. And mention should also be made of a dignified gold chalice which has been executed for the Brompton Oratory.

To many people, however, the most interesting feature of the exhibition lay in the artistic taste and skill which Messrs. Ramsden and Carr have brought to bear on the ordinary articles of domestic use. Tea-pots, milk-jugs, sugar-basins, claret-jugs, knives and forks, fire-irons, door-furniture—for all these they have invented new and charming designs, and their work proves not only that these common-place articles may all be things of beauty, but also that they may be obtained at a cost little if at all exceeding the prices paid for the ordinary articles which disfigure so many of our houses.

HOME INDUSTRIES.

Standardising Cotton.—Mr. C. W. Macara, of Manchester, chairman of the International Federation of Cotton Spinners, has received a letter from the United States Department of Agriculture, in which he is informed that Congress has directed the Secretary of Agriculture of the American Government to establish official standards of nine grades of American cotton. The intention is to have one set of standards for the entire country, so as to secure uniformity in price quotation, and eliminate as much reclamation as possible, there being at the present time different standards of cotton in differnt parts of the United States that create confusion, dissatisfaction, annoyance, and loss to the producers, the cotton trade, and the spinner. It is desired to establish an international standard for American cotton, and it is the intention to invite a committee to meet in conference with the Department of Agriculture in Washington early in 1909. Any recommendations made by the conference will have great weight with the American Secretary of Agriculture in preparing the nine official standards directed by Congress, and it is hoped that other countries may adopt similar standards. It is thought that two or three days in Washington will be sufficient. The Department of Agriculture will refund travelling expenses of the members. All the facilities of the Department of Agriculture will be placed at the disposal of the members of the Committee. Mr. Macara is invited to suggest the names of a number of gentlemen prominent in the cotton business that three may be selected from among them, one man for each of the three most important cotton manufacturing nations of Europe. It is not intended that the members of the Committee shall officially represent any cotton exchange or firm, but shall act simply in the interests of the entire cotton industry. In Mr. Macara's opinion — doubtless shared by other representative cotton spinners—the Conference suggested by the United States Department of Agriculture is a development which, if carried out successfully, will prove to be of great advantage to the cotton industry. It is, he considers, a direct outcome of the International Conference of the Spinners of the World and the Cotton Spinners of America, held in the autumn of last year at Atalanta, Georgia.

Meat Supplies.—For some time past statements have been current as to the likelihood of serious increase in the price of meat, and the outbreak of foot and mouth disease in the United States is not calculated to allay the rather vague fears caused by these predictions, and the idea that in some mysterious way an American syndicate has succeeded in obtaining the control of the surplus meat supplies of South America. But whatever the future may have in store, the past few weeks have seen prices exceptionally low. Arrivals of Argentine chilled beef have been very heavy, and prices as low as 2¾d. per lb. have been accepted for both hind quarters and fore quarters. Even at these figures the supply has exceeded the

demand and two or three of the meat companies have frozen considerable quantities of their supplies. English, Scotch, and town-killed American beef have not suffered to the same extent, only the inferior ranch meat being sold at low prices, but the market has been very slow. The foot and mouth disease in the United States will probably improve prices a little, but it is not expected that there will be anything like a dear market before the end of the year. Shipments of dressed beef are expected to increase. Prices of mutton have been low for some months past, English meat being quoted at 5d. and Dutch at 4d. per lb. The sheep are said to be in such large nnmbers in Holland that consignments to this country may be expected to continue heavy for the rest of the year. The immediate outlook for graziers is not encouraging.

Bottle Making.—It seems that the operative bottle makers of St. Helen's are apprehensive that mechanical means are about to be introduced which will cause a revolution in the manufacture of these articles, and a considerable displacement of labour. The processes are still carried on by hand mainly, and this is one of the few skilled operations left in the town. Hartlepool workmen in the bottle trade have displayed strong opposition to the use of machinery, and have, as a rule, refused to work. The machinery introduced has, however, not been satisfactory, and employers have not been reluctant to part with it. But about two years ago an American syndicate put down a machine bottle-making plant at Trafford Park, and if the *Manchester Guardian* is well informed, as no doubt it is, this has proved to be such an improvement on anything tried before that an extension of its use would render obsolete the old system of manufacture such as is carried on in the districts of . Helens and Barnsley. A syndicate of English and Continental bottle manufacturers "pooled" sufficient capital among themselves to buy the European patent rights at a big price, and steps are being taken by the employers to introduce the invention at St. Helens. It is claimed that the machine with ten attendants—who need not necessarily be skilled men—can do the work of 70 men in any given time. If that is near the truth the uneasiness of the St. Helens bottle makers is not surprising.

The Yorkshire Woollen Industry.—It may be hoped and expected that some good will be derived from the visit of the deputation of Yorkshire workmen who are now studying the conditions of the woollen trade in Germany. The members of the party were drawn from Dewsbury, Batley Carr, Batley, Bristow, and Thornhill Lees. For some time past the heavy woollen trade of Yorkshire has been stagnant. Professor Clapham, in his recent work on the woollen industry, states that the number of woollen spindles fell by 15 per cent. from 1889 to 1904, while the number of woollen looms was reduced from 61,831 to 50,357, and worsted looms from 67,391 to 52,725. In the same year worsted spindles had increased by 22 per cent., but against the reduction in the number of looms there has been an increase in speed and width. One explanation of the present unsatisfactory state of the trade is that it is due to a lack of initiative, enterprise, and business organisation. Perhaps the German visit may help to alter things.

Post-office Insurance.—The Departmental Committee appointed by the Postmaster-General to consider how best the life insurance system of the Post-office can be encouraged, makes various suggestions in its report. It is admitted that the methods of conducting the insurance business of the Department have not been progressive, and the Committee recommends, among other things, that the maximum insurance, allowed on any one life, be increased to £300, that wider powers be acquired in respect of the investment of funds, and that simple and attractive advertisements, dealing only with the insurance scheme, be made use of. It is expected that the amended scheme will largely appeal to earners of weekly wages, and therefore some arrangement for the weekly payment of premiums is regarded as essential. The Committee does not, however, recommend any system of house to house collection, or personal canvass, the two items which swell so seriously the expense ratio of the ordinary industrial assurance company. The difficulty the Post-office will have to reckon with is the indifference of the average working man is the matter of insuring his life. He will not take any trouble about it. If he is not pressed by a canvasser to insure he will leave it alone, and even when insured, if there is no personal application for payments due, he does not, speaking generally, make them. The Committee do not indicate how these difficulties are to be overcome by the Post-office authorities.

Accidents in Workshops.—The Home Secretary has recently appointed a Committee to inquire into the cause of the increase in the number of accidents reported in certain workshops and other premises under the Factory Acts, a step which makes the figures contained in the Blue-book lately issued with reference to accidents during 1907 more than usually interesting. In all there were 3,330 cases of accidents occurring in England and Wales taken into Court, and of these 835 were brought under the Act of 1906. Eighty-four per cent. of the cases settled in Court were decided in favour of the applicant, as compared with 83 per cent. in 1906, and 82 per cent. in each of the two years 1905 and 1904. In 539 cases compensation was awarded on account of death, and in all except two of these cases the victim had left dependents. Since the passing of the Act of 1907 the number of cases dealt with by the Courts has largely increased. In 1899 it was 1,347; last year, as stated above, it was 3,330, and the returns for 1907 include only six months' working of the Act of 1906.

Marks of Origin in France.—British merchants frequently complain of the rivalry in France of French manufactured goods masquerading as British. But the recent decision of the French Court of Cassation shows that they have their remedy if they choose to appeal to the French Courts. A firm of brewers at Lyons sold a beverage which they described as Munich Beer, the casks bearing upon them the word "Munichen." The President of the Brewers' Union at Munich, Mr. Pschorr, commenced a prosecution in France on December 9th, 1904. The Court of Appeal at Lyons forbade the defendants to use the expression "Biere Munich," though they were authorised to describe it as "Biere Genre Munich." Mr. Pschorr and the other plaintiffs recovered damages, and the defendants stated that they voluntarily renounced the use of the word "Munichen" on their casks. The *locus standi* of Mr. Pschorr was called in question by the defendants during the trial, and it was decided that the fact of his being a brewer at Munich was sufficient to entitle him to sue in his personal name, though the presidency of the Brewers' Union gave him no such right. The Court of Cassation has now confirmed this judgment. The law governing the matter dates back to 1824, and prohibits the affixing to manufactured articles of the name of the place other than that of its manufacture. Thus any Redditch manufacturer of needles, or Sheffield manufacturer of cutlery, may repress the sale or manufacture in France of needles or cutlery bearing the names of Redditch or Sheffield when the goods have not really been manufactured in those places.

Mineral Output of the United Kingdom for 1907.—The following figures are taken from the General Report on Mines and Quarries for 1907, which is issued by the Home Office:—"The total value of the minerals raised [in the United Kingdom] during the year amounted to £135,279,088, an increase of £29,436,096 as compared with 1906. This increase is accounted for by the increased output of coal and rise in the average price of coal, viz., from 7s. 3·49d. per ton in 1906 to 9s. in 1907. The total output of coal, 267,830,962 tons, which was the highest hitherto recorded, and the value, £120,227,378, show increases of 16,763,334 tons and £28,998,112 respectively on the figures for 1906. The quantity of coal exported, exclusive of coke and patent fuel and of coal shipped for the use of steamers engaged in foreign trade, was 63,600,947 tons, an increase of more than eight million tons on the exports for 1906. France received over 10¾ million tons, Germany over 10 million tons, Italy over 8¼ million tons, the Netherlands over 3¼ million tons, Sweden over 3¾ million tons, and Russia, Spain, Denmark, Egypt, and the Argentine Republic each over two million tons. Adding the 2,968,501 tons exported in the form of coke and patent fuel, and the 18,618,828 tons shipped for the use of British and foreign steamers engaged in foreign trade, the total quantity of coal which left the country was 85,188,276 tons. The amount of coal remaining for home consumption was 182,642,686 tons, or 4·142 tons per head of the population. 21,119,547 tons were used in the blast furnaces for the manufacture of pig iron, as against 20,836,795 tons in the previous year. During the past 35 years (1873-1907) the total value of the mineral coal raised amounts to £2,731,688,000, and of this sum coal accounts for £2,245,103,000 or 82 per cent. 6,231,104,000 tons of coal have been raised in that period; and of this amount 1,404,654,000 tons, or 22 per cent. of the total production, have been shipped abroad as exports in the form of coal, coke, and patent fuel, and as coal used for steamers engaged in foreign trade."

NOTES ON BOOKS.

NATURE AND ORNAMENT. By Lewis F. Day. London: B. T. Batsford. 8vo. 5s. net.

The general purpose of this book, as stated by the author, is "to show the development of ornament from natural form, and its constant relation to nature, and further to deduce from the practice of past masters something like guiding principles to help the student in making his own best use of natural form in ornament."

The present volume is the first of two, of which the second will appear shortly. The special purpose of this volume is to illustrate as fully as possible the decorative and ornamental character of natural growth, and its suggestiveness as the starting point of design. The book is profusely illustrated by Miss Foord. Her work consists for the most part of sample drawings of plants, but they are executed with an exact knowledge of plant form, and are well adapted to advance their objects, which are "(1) to indicate the fulness and variety of suggestion everywhere in nature; (2) to show the kind of nature study which is most helpful towards design; (3) to call attention to sources of inspiration which have not been drawn upon by the designers as they might be."

The book should prove of great service to all students of design.

THE COMMERCIAL PRODUCTS OF INDIA. By Sir George Watt, C.I.E., M.B., C.M., LL.D., F.L.S. London: John Murray. Large 8vo. 16s. net.

This volume is a corrected and abridged edition of the author's "Dictionary of the Economic Products of India," which was written and published in the years 1885-94, and has for some time been out of print. It is published under the authority of His Majesty's Secretary of State for India; the plan of the work was settled by a small committee, consisting

of Sir W. T. Thiselton-Dyer, F.R.S., Mr. T. S. Gamble, F.R.S., Professor W. R. Dunstan, F.R.S., Sir Thomas Holderness, and Lieut.-Col. D. Prain, F.R.S., and when it is added that the highest authorities on the various subjects dealt with have placed their services at the disposal of Sir George Watt, it will be seen that the book must be regarded as a standard work of reference. Perhaps the best way to convey some idea of the care which has been bestowed upon the work, is to mention the various headings under a particular entry. To the plant, coffee, for instance, are devoted thirty pages of closely printed small type. A paragraph is given to the various names by which the plant has been known; a second to its *habitat*. Then follows a long and interesting history of its use in various countries throughout the world. This is succeeded by a section on its cultivation, with particulars of distribution, yield, methods of propagation, drainage, manures, pruning, and the pests and blights which attack the plant; and finally some useful information is given with regard to the manufacture and trade in coffee. A very complete index adds greatly to the value of the work.

THE SHORES OF THE ADRIATIC. By F. Hamilton Jackson. London: John Murray. Large 8vo. 21s. net.

This volume deals with the Austrian side of the Adriatic, the Küstenlande, Istria, and Dalmatia. It is complementary to that which described the Italian side, and is written on similar lines. There is abundance of material both for pen and pencil in a country which contains so many medieval survivals in customs and costumes, so much that is fine in scenery, architecture, and the decorative arts, and the author has not been slow to take advantage of his opportunities. Some of the most interesting pages are those which describe the various races and their customs. The peasants of Dalmatia are a tall, muscular, and hardy set of men. "Their excellent health enables them to support all kinds of hardships. They sleep out of doors (covering the head), except in winter, at which season they stay a good deal by the fire, though they may be seen in the city with icicles on their hairy chests. They have neither stoves, chimneys, nor glass in the windows. A case of a monk has been recorded, who, at the age of 105, made watches and read with the naked eye, ate and drank, walked and 'wept' like a boy of twenty."

The book, which is written in a chatty and readable style, contains a great deal of heterogeneous information — historical, geographical, architectural, sociological—but perhaps its chief value lies in the illustrations with which the author has enriched his text. His drawing of the north door of the western facade of Zara Cathedral, *e.g.*, is a very beautiful piece of work, and conveys an excellent idea of the elaborate arabesque scrolls and extraordinarily rich ornament of the cathedral. Some striking photographs are also included in the volume.

OBITUARY.

HENRY CHAPMAN.—Mr. Henry Chapman, who died on October 18th, was a well-known engineer, and played an important part in the development of British trade with the Continent, and especially with France. He was born at Dieppe in 1835, being the son of Mr. George Chapman, who was for nearly fifty years British Consul in that town. After serving under articles for five years to Messrs. Sharp, Stewart and Co., then of Manchester, he was employed to represent them abroad, but in 1858 he set up in business as a consulting engineer in Paris. In this capacity he was engaged by many French railway companies in providing designs and specifications for rolling-stock, for fixed mechanical plant, and for the arrangement and equipment of workshops. He was a strong advocate of the application of machine tools actuated by hydraulic power, and he was also associated with Mr. Peter Brotherhead in torpedo machinery and air compression. Mr. Chapman became a Member of the Society in 1868. He was also for many years a member of the Institution of Mechanical Engineers, and a vice-president in 1907. He was decorated by the French Government in 1878 as Chevalier of the Legion of Honour, and was promoted to the rank of officer in 1889.

GENERAL NOTES.

VENICE INTERNATIONAL ART EXHIBITION.—The Municipal Council of the City of Venice announce that their Eighth International Art Exhibition will be held from April 22nd to October 31st, 1909. It will contain pictures, sculptures, drawings, engravings, and objects of decorative art; and will be divided into Italian, Foreign, and International Rooms. Works intended for exhibition must be notified to the Secretary not later than January 1st, 1909, and delivered at the buildings (*Giardini Pubblici*) between March 10th and 25th.

LECTURES ON THE HISTORY OF THE MEAT INDUSTRY.—With reference to the article on the Geneva International Food Congress, which appeared in the *Journal* on November 6th, it is interesting to notice that a series of lectures on the history of the meat industry is being given this winter at the College of Agriculture, Edinburgh, by Mr. Loudon M. Douglas, of Edinburgh, who is well-known as a writer and lecturer on the subject of foods and the various branches of industry associated with the meat trade. The lectures will deal with cattle markets, abattoirs, refrigeration, the meat supply, laws affecting the meat trade, meat inspection, diseases of animals used for food and their detection, pickling and curing of meats, the manufacturing of sma

goods, &c. Arrangements have also been made for a number of excursions to different places in connection with the meat industry in order to study the actual practice.

Motoring in Italy.—As it is sometimes difficult for British subjects to understand the formalities required on their entering Italy by land or sea with their motor-cars, Mr. Consul de Zuccato, in his report on the trade and commerce of Venice (No. 4122, Annual Series) states for their information that they have to make application to a Custom-house on a sheet of stamped paper of 2 lire 40 c. (1s. 11d.) for a provisional permit of importation, which will be valid for three months, and deposit at the same time for each motor-car a sum of 650 lire (£26) which will be returned to them, less a small registration fee, on their leaving the kingdom at any frontier point where there is a Custom-house. In case they want the permit to be prolonged for another three months they must make their application some days before the expiration of the original permit, and pay the "tassa di circolazione" according to the weight of their cars. Should they neglect to go through this formality in time they would forfeit the deposit, and would have to pay the "tassa di circolazione" all the same for one year. In the event of a British motorist meeting with trouble whilst touring in Italy, the Consul thinks the best plan for him would be, after obtaining legal assistance, to try to compromise the case at once, or, if that should not be possible, to request the Court to be allowed to make a provisional deposit of a sum to be fixed, as otherwise his car would be sequestrated, and probably the chauffeur would be detained, possibly for several weeks, at the expense of the owner, until proper evidence could be obtained.

Coachbuilding Prizes.—The Company of Coach Makers and Coach-harness Makers of London offer the following prizes for competition among the British subjects engaged in coach and coach-harness making, motor-body making, and accessory trades, and members of drawing and technical classes in connection with such trades, resident in the United Kingdom of Great Britain and Ireland:—Competition No. 1 (open to all)—For drawings in ink of a wagonette-omnibus (the head to be removable) to be drawn by two horses; seating accommodation for two persons on the driver's seat, four on roof (a removable seat), and eight inside, elbow line of body 6 feet 6 inches outside measure, wheel track 4 feet 10 inches, front and hind wheel to track, suitable brake, and luggage rail to roof to be shown; scale 3 inches to the foot, on two pieces of paper 5 feet by 3 feet each; one design to show side and half-back elevations with head, the other design to show side and half front elevation with head; 1st prize, the Company's silver medal and £10 10s.; 2nd prize, the Company's bronze medal and £5 5s. Competition No. 2 (open to coach smiths)—For practical iron work (as it leaves the forge, no viceing), suitable for a one-horse bottom fore-carriage, in five distinct pieces; 1st prize, the Company's silver medal and £4 4s.; 2nd prize, the Company's bronze medal and £2 2s. Competition No. 3 (open to trimmers)—For the best designed upholstery for the door of a landaulette, not less than 24 inches wide, to be effected in cloth, either plain or corded, and with or without lace: 1st prize, £3 3s.; 2nd prize, £2 2s. Competition No. 4 (open to all)—For coloured or tinted drawings of a Limousine motor-car body without chassis, to carry two persons on the front and two on the principal hind seat, with additional seats for two persons; side view and longitudinal section elevation showing the interior; scale one inch to the foot; on paper 36 inches by 18 inches; 1st prize, £4 4s.; 2nd prize, £2 2s. Competition No. 5 (open to apprentices under 21 years, with evidence in writing, if required)—For drawings in ink of a four-seated side-entrance open motor-car body, with cape hood and wind screen, on any type of chassis; side view, half plan and half back; scale 1½ inches to the foot; on paper 36 inches by 24 inches; 1st prize, £3 3s.; 2nd prize, £1 1s. Competition No. 6 (open to sons of master coach builders, clerks, storekeepers, or other employees of coach builders or motor body builders)—For essays on decorations in modern carraiges having regard to taste and harmony in painting and upholstery, on foolscap, not exceeding ten pages; £5 5s. will be awarded in one or more prizes according to merit. The above prizes will be accompanied by the certificate of the Company.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

December 9.—"Kinematography in Natural Colours." By G. Albert Smith, F.R.A.S., and Charles Urban, F.Z.S. Sir John Cameron Lamb, C.B., C.M.G., Member of the Council, will preside.

December 16.—"London Milk Supply from a Farmer's Point of View." By Primrose McConnell, B.Sc., F.C.S. Sir George Barham, J.P., President of the British Dairy Farmers' Association, will preside.

Papers for Meetings after Christmas (dates not fixed):—

"The Commercial Relations of France and Great Britain." By Monsieur Yves Guyot.

"Railway Development in China." By Arthur John Barry, M.Inst.C.E.

"The Application of the Microscope to the Study of Metals." By Walter Rosenhain.

"The Resources of Peru." By C. Reginald Enock, F.R.G.S.

"Afforestation and Timber Planting in Great Britain and Ireland." By J. Nisbet.

"Destruction of Vermin." By A. E. MOORE (Secretary of the Incorporated Society for the Destruction of Vermin).

"The Problem of Unemployment." By BOLTON SMART (Superintendent of the Hollesley Bay Labour Colony, Suffolk).

"Gothic Art in Spain." By HENRY C. BREWER.

"Hand-made Papers." By CLAYTON BEADLE and HENRY P. STEVENS, M.A., Ph.D.

"Some Phases of Hinduism." By KRISHNA GOBINDA GUPTA (Member of the Council of India).

"Early Buddhist and Hindu Architecture and Sculpture." By A. A. MACDONELL (Boden Professor of Sanskrit, Oxford).

"The Function of Schools of Art in India." By CECIL L. BURNS (Principal, Bombay School of Art).

"The Problem of Indian Labour Supply." By SELWYN HOWE FREMANTLE, I.C.S.

"Ceylon, the leading Crown Colony, in 1909." By the HON JOHN FERGUSON, C.M.G.

INDIAN SECTION.

Thursday afternoon, at 4.30 o'clock :—

DECEMBER 10.—"The Birds of India." By DOUGLAS DEWAR, I.C.S. SIR EVAN JAMES, K.C.I.E., C.S.I., will preside.

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

OSCAR GUTTMANN, M.Inst.C.E., F.I.C., F.C.S., "Twenty Years Progress in Explosives." Four Lectures.

LECTURE III.—DECEMBER 7.—History of smokeless powders—Their manufacture—Flameless powders—Fulminates and detonators—Fuses—Safety explosives.—What renders an explosive safe in fire damp?—When is an explosive safe?—Coal dust—Safety explosives in practice.

LECTURE IV.—DECEMBER 14.—Use of nitrocellulose for celluloid, artificial silk and varnish—Machinery driven by explosives—Factories, their inspection, construction and accidents—Precautions recommended — Electric lighting — Static electric charges—The merits and demerits of explosives—Stability and its proof—Stability in practice—Accidents with smokeless powder — Stabilizers — The powder of the future.

G. L. ADDENBROOKE, M.I.E.E., "Electric Power Supply." Three Lectures.

January 18, 25, February 1.

LEON GASTER, A.M.I.E.E., "Methods of Artificial Illumination." Four Lectures.

February 15, 22, March 1, 8.

GEORGE GERALD STONEY, M.Inst.C.E., "Steam Turbines." Three Lectures.

March 22, 29, April 5.

F. W. LANCHESTER, "Aerial Flight." Three Lectures.

April 26, May 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 7...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. O. Guttmann, "Twenty Years Progress in Explosives." (Lecture III.)

Farmers' Club, Whitehall-rooms, Whitehall-place, S.W., 6 p.m. Mr. Sanders Spencer, "The Past, Present, and Future of British Agriculture"

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7½ p.m. Mr. Herbert Chatley, "Mechanical Flight."

Chemical Industry (London Section), Burlington-house, W., 8 p.m.

Geographical, Burlington-gardens, W., 8½ p.m. Lieut. A. Trellé, "The Danish North-East Greenland Expedition."

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Prof. Edward Hull, "Geneva and Chamounix of to-day as compared with half-a-century ago."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. M. Phillips, "Romance in Banking."

TUESDAY, DEC 8...Asiatic, 22, Albemarle-street, W., 4 p.m. Professor F. Garstang, "Recent Explorations in Asia Minor."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. E. H. Tabor, "The Rotherhithe Tunnel."

Aeronautical (in the ROOMS OF THE ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.) 8 p.m.

Photographic, 66, Russell-square, W.C., 8 p.m. Address by the President, "The Progress of Photography among the Arts."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8 p.m. Prof. H. Egerton, "Oxford and the Empire."

WEDNESDAY, DEC. 9...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Messrs. G. Albert Smith and Charles Urban, "Kinematography in Natural Colours."

Japan Society, 20, Hanover-square, W., 8½ p.m., Mr. A. G. Moslé, "The Sword Ornaments of the Goto Shirobei Family."

African Society, Trocadero, Piccadilly, W., 8½ p.m. Mr. F. C. Selous, "Big Game in South Africa."

United Service Institution, Whitehall, S.W., 3 p.m. Discussion on "The Standard of Naval Strength."

Auctioneers', 34, Russell-square, W.C., 8 p.m. Mr. H. Griffiths, "London Taverns in English History and English History in London Taverns."

THURSDAY, DEC. 10...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section) Mr. Douglas Dewar, "The Birds of India."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institute, Finsbury-circus, E.C., 6 p.m. Sir Alexander Mackenzie, "Brahms."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. 1. Messrs. J. C. Macfarlane and H. Burge, "Output and Economy Limits of Dynamo Electric Machinery." 2. Mr. John Roberts, "Commercial Electric Heating."

CORRECTION.—Page 38, col. 1, line 29, in the discussion on Sir W. Martin Conway's paper, "The Goldfields of Eastern Peru and Bolivia," *for* "Incahuara" read "Inambari."

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FRIDAY, DECEMBER 11, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, DECEMBER 14, 8 p.m. (Cantor Lecture.) OSCAR GUTTMANN, M.Inst.C.E., F.I.C., F.C.S., "Twenty Years Progress in Explosives." (Lecture IV.)

WEDNESDAY, DECEMBER 16, 8 p.m. (Ordinary Meeting.) PRIMROSE MCCONNELL, B.Sc., F.C.S., "London Milk Supply from a Farmer's Point of View."

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURES.

On Monday evening, 7th inst., Mr. OSCAR GUTTMANN delivered the third lecture of his course on "Twenty Years Progress in Explosives."

The lectures will be published in the *Journal* during the Christmas recess.

COLONIAL SECTION COMMITTEE.

A meeting of the Committee of the Colonial Section was held on Monday afternoon, 7th inst. Present: — Sir Westby B. Perceval, K.C.M.G. (in the chair), Byron Brenan, C.M.G., Hon. Sir Charles W. Fremantle, K.C.B., Rt. Hon. Sir Joseph West Ridgeway, G.C.B., G.C.M.G., K.C.S.I., Earl of Stamford, Carmichael Thomas, Sir William Hood Treacher, K.C.M.G., Sir Frederick Young, K.C.M.G., with S. Digby, C.I.E., Secretary of the Section.

INDIAN SECTION.

Thursday afternoon, December 10th; SIR H. EVAN M. JAMES, K.C.I.E., C.S.I., in the chair. A paper on "The Birds of India" was read by DOUGLAS DEWAR, I.C.S.

The paper and discussion will be published in the *Journal* during the Christmas recess.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience, will be delivered on Wednesday afternoons, January 6th and 13th, at 5 o'clock, by Charles Waldstein, Litt.D., Ph.D., Slade Professor of Fine Art in the University of Cambridge, on "Digging for Ancient Art Treasures."

Each Member is entitled to a ticket admitting two children and an adult.

A sufficient number of tickets to fill the room will be issued to Members in the order in which applications are received.

Members who desire tickets for the course are requested to apply for them at once.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready and can be obtained by members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1s. 6d. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

FOURTH ORDINARY MEETING.

Wednesday, December 9, 1908; Sir John Cameron Lamb, C.B., C.M.G., Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Broadbent, Cecil, 63, St. James's-street, S.W.
Burton, Henry, Messrs. Partington and Co., Victoria-embankment, W.C.
Everest, Miss Ethel Gertrude, Chippens Bank, Hever, Kent.
Macgowan, Rev. John, Amoy, China.
Probert, Rev. William Mitchell, 71, Gore-road, Victoria-park, N.E.
Singer, Adam Mortimer, 78, Mount-street, Grosvenor-square, W.

The following candidates were balloted for and duly elected members of the Society:—

Bain, John Anderson, The Vacuum Oil Company, York-house, Norfolk-street, Strand, W.C.
Barbour, John Milne, M.A., J.P., Conway, Dunmurray, Co. Antrim, Ireland.
Greenway, Charles, Stratton Chase, Chalfont St. Giles, Bucks.
Hart, George, 28, Wardour-street, W.
Low, Charles Watson, 23, Wellington-court, Knightsbridge, S.W.
Murray, John, F.R.I.B.A., 11, Suffolk-street, Pall-mall, S.W.
Sheppard, V. L. Osborne, Survey Department, Kafr el Zayat, Egypt.
Smith, Caleb J. R., 29, Gerrard-street, Soho, W.
Wood, Mrs. W. Martin, Underwood, Oatlands-avenue, Weybridge, Surrey.
Wylie, John Howie, Agates, Herstmonceux, Hailsham, Sussex.

The paper read was—

ANIMATED PHOTOGRAPHS IN NATURAL COLOURS.

By G. Albert Smith, F.R.A.S.

It is a pleasure to respond to-night to the invitation of the Royal Society of Arts to describe briefly a rather long course of experimental work carried out with an interesting object in view—that of reproducing by means of photography moving scenes in their natural colours.

The subject of colour photography has been very much to the fore of late, and the main lines upon which the work is done are so widely understood that it is unnecessary to go very fully over rudimentary ground in introducing the subject to an audience like the present one.

But we are to deal with that branch known as "animated" photography, and as I often find that though most people are familiar enough with the results as exhibited at the places of amusement, they are not always quite clear about the process, it seems desirable to outline briefly the principles of the art.

Briefly stated, animated photography is snap-shot photography, without much interval between the shots. To do the work you provide yourself with a special camera and a roll of sensitive film, which latter may be of any length from, say, 50 to 500 feet, and on this film you take snap-shots at the rate of 16 per second. A handle on the camera actuates machinery which carries the film forward. You turn the handle at a speed which causes the film to pass behind the lens at the rate of one foot of film for every second of time, whilst a revolving shutter with an opening in it permits 16 images to the foot to fall in rotation upon the travelling sensitive surface. It is important to note that the sensitive film is not travelling past the lens continuously; the machinery causes it to stand still momentarily while the actual snap-shot is being taken, and whilst the film is being whisked forward preparatory to another snap-shot being recorded, the revolving black shutter intervenes to protect the moving film from light. Thus the film jumps forward 16 times every second, and stands still 16 times every second. When all the film has run through the camera, or when you think enough of the scene has been recorded, the film is developed like any other negative. When dry, a contact print is made on another piece of transparent film of corresponding length, and when that print is finally developed and dried it is ready to exhibit to an audience. It is run through a machine fitted with a lens and provided with a good light, in such a manner that the snap-shots are projected just as lantern slides are shown, only that they change at the rate of 16 per second. A black shutter here again revolves and obliterates the light every time a picture changes. The sheet is, therefore, being bombarded with a stream of snap-shots at such a rapid rate that before one snap-shot has had time to fade from the observer's retina another one is in view, and as each view is a record slightly different from its predecessors, the illusion of movement is conveyed. The part played by persistence of vision

in this process is important, because we shall meet with that phenomenon again presently.

It is admitted that "animated photographs" are of great interest and educational importance, enabling us, as they do, to participate at our ease in scenes and happenings which we can never witness without their aid. But now that the extreme novelty and wonder of the thing have lost their first spell over our minds, how frequently the thought occurs that if only *colour* could be added a much more realistic impression of the situation would be conveyed. Personally, I have frequently had the desire for colour during the twelve years that I have been actively interested in the animated picture industry; but I think I date my determination to do what little within me lies to bring about that desired end from the time of the funeral of our late Queen, when it was my sole privilege to cinematograph the scene on the steps of the Chapel Royal, Windsor Castle. The picture that I obtained on that occasion, though a faithful record of movement and incident, conveyed no suggestion whatever of the gorgeous colouring of that historic scene. The rich uniforms of our King and Princes, the gorgeous tunics, plumes, and gold braidings of the great representatives of continental and other countries, made a blaze of moving colour on the broad steps of the Chapel which I shall never forget. My picture, of course, conveyed nothing of all this, and to my mind lost nine-tenths of its interest and truth in consequence. The same lament applies to almost all military scenes, in my opinion; and numerous other cases will occur to all of you where, if we could only reproduce *colour* as well as movement, a much more realistic and valuable record would result.

But how is it to be done? What methods are open to us? Science tells us, with proofs that cannot be disputed, that there is no such thing as colour in an objective sense; colour is a sensation—a something supplied by our own minds—a subjective phenomenon entirely. A red object is conveying to our eyes a series of physical impulses numbering some millions per second; a violet object is sending impulses at nearly double the rate; other colours are sending impulses at different rates per second; and the brain translates these different impulses into sensations which we term colour. Colours, then, in all their innumerable shades and gradations, are actually impulses, shocks, or waves of varying intensity and proportion, each impulse or shock having its own characteristic velocity by which we recognise it and assign it its value.

Scientifically speaking, in the light of our knowledge to date, the photographer who sets out to record colour is seeking to record what does not exist outside of his own mind! Apart from his own brain, the beautiful colours and gorgeous tints around him are "oscillations of the ether;" and any experimenter who fails to grasp this scientific proposition and to work in the light of it is handicapped indeed.

Students of photography and of colour phenomena are well aware that the scientific performance of Professor Lippman some thirteen years ago still ranks as the only real "photography in colours." He passed the focussed picture in his camera through an extremely thin and transparent sensitive emulsion on to a wall of mercury. Thence the colour waves rebounded, and by what is known as interference set up a permanent chemical change in the thin film. The light waves became, as it were, stationary, and revealed colours when viewed at a certain angle in reflected light. Such pictures require an exposure of at least a quarter of an hour in good sunlight. The colours are not always quite satisfactory (white is not at all well rendered) and the picture cannot be reproduced. The process is of intense scientific interest, but has no other practical value.

It appears, then, that in the present state of knowledge the most we can hope to do photographically in the pictorial registration of colour is to record the particular colour waves in any scene in a scale—from white ranging through intermediate greys to black, subsequently translating these neutral gradations back into colour terms by some artifice with coloured lights or dyes.

Some authority has, I believe, laid down the proposition that the human eye is a very imperfect optical instrument. However that may be, it is very certain that the photographic plate is much more imperfect. The photographic plate is partly colour-blind. It is said that some ladies in church are so much absorbed in the millinery that they necessarily bring away a very imperfect impression of the sermon. The photographic plate when put to work is so much impressed by the colours violet and blue, *i.e.*, ether oscillations of high frequency, that it omits to give anything like an adequate rendering of the slower oscillations which human eyes recognise and designate as orange and red. Every amateur photographer knows how sluggishly responsive,

comparatively speaking, his plates are to red rays, and for that reason he develops and inspects them in red light. Consequently, before photographic plates can be made to record colour waves, even in terms of neutral greys with white at one end of the scale and black at the other, they must be induced to see things more as human eyes see them. At present, whilst the human eye says that yellow is the most luminous colour next to white itself, the photographic plate says that violet is. Whilst the human eye says that scarlet is a very bright and luminous colour, the photographic plate says it can scarcely see it at all.

So far as is generally known, the only way to make photographic plates see more as we see is to doctor them in very carefully arranged conditions with certain of the curious dyes derived from the by-products of coal. By a course of experimental doctoring of this sort, extending over the past three years, I have found it possible to make cinematograph film as sensitive, for all practical purposes, to red as to white. Thus a negative taken in the sixty-fourth of a second through a piece of red glass of two ladies, one dressed in scarlet and one in white, shows the dresses recorded with equal intensity. This is in harmony with the testimony of the human eye in similar conditions, as we shall find if we take a piece of red glass and look through it at two ladies dressed as I have described.

Apart from the beautifully scientific but impracticable process of Professor Lippman previously alluded to, the only field of operations presented to our view (assuming that we have secured a photographic medium sensitive to all colours of the spectrum) is the three-colour theory promulgated by Thomas Young early in the last century, and since adopted in every process of colour photography with which I am acquainted. This theory refers all human colour sensations to three primary ones—red, green, and violet. It suggests that we have a sort of triple seeing-mechanism capable of exciting sensations in the mind when stimulated by light-waves, and that all the colour sensations we experience are caused by the stimulation and activity of these triple avenues in varying proportions.

Whether the three-colour theory is in accordance with physiological facts or not need not be discussed. Sufficient is it for us that its adoption gives a practical working hypothesis, and as expounded and practised by Ducos du Hauron, Dr. Joly, M'Donough, Ives, Lumière, Sanger Shepherd, and others, gives us pleasing reproductions in colour. The applications of the theory are almost as old as most of us in this room; and we have seen from time to time lantern slides of still subjects beautifully produced by methods based on it.

Briefly, the theory indicates that, applied to photography, we are to take a photograph through red glass, which, by cutting out all other rays, permits us to secure a record of all that is red in the view and of all that relates to red; we are to take another through a green glass and so obtain a record of green, and of all that relates to green and of nothing else; finally we are to take a third photograph through a violet glass and secure a record of all that is violet and of all that relates to violet. When these three photographs are ultimately viewed in the coloured light that belongs to each, and they are somehow superimposed so that we view them all at once, each picture will contribute the requisite proportion of colour recorded in it and the reconstruction of the coloured scene will be complete.

The simplest illustration of the principle is perhaps the triple lantern, when the top lantern may shed a light through red glass on the sheet, the middle lantern may throw light through green glass, and the bottom lantern supply a beam of violet light. These three beams of coloured light superimposed upon the sheet will form white light. Then if the photographs, taken as described, and made into lantern slides, are inserted in their appropriate lanterns, and correctly focussed and superimposed on the sheet, the proportions of coloured light passed through the three slides suffice to reproduce to our eyes the proportions of colour in the original scene.

The most startling example of the three-colour theory is admittedly afforded by the recently-introduced and wonderful Autochrome plate, in which, by the marvellous skill of the brothers Lumière, the required colour filters are embodied as microscopic particles in the photographic plate itself, so that one exposure secures the photograph in three-colour value, and, when finished, a light at the back of the plate enables us to see the three colours in proper proportion. The multitude of microscopic filters (red, green, and violet) embodied in the plate abolish all the intermediate steps necessary before the introduction of the plate, and at the same time afford the most brilliant example of the application of the three-colour principle.

The three - colour principle having been proved by numerous lines of demonstration to be a sound working theory, it would naturally suggest itself as being applicable to animated pictures; and, judging by the records of the Patent Office, there are plenty of people who have thought so. But it is to be feared that in the rush to the Patent Office the details of experiment and trial have generally been overlooked.

Some years back (1902), I was invited by Mr. Charles Urban to assist in a thorough trial which he was making, regardless of reasonable expense, of a three-colour process applied to the cinematograph. At that date very little was known about the possibilities of sensitising film to red and green, and, to that extent, we were handicapped, although we had very expert assistance. Nevertheless, in good sunlight we did succeed in taking a few negatives in which the three colours were duly recorded. It was when we came to superimpose the pictures on the sheet through three coloured glasses that we found the process unworkable. As soon as the handle of the projecting machine was worked the three pictures refused to remain in register, and no knowledge that any of us could bring to bear upon the matter could even begin to cure the trouble. I do not know whether any other workers, if there are any, succeeded where we failed; but, if they did succeed, the public have never, so far as I am aware, been permitted to see the results. The difficulty is mainly due to the fact that cinematograph pictures are small to begin with (about the size of a postage stamp), and they have to be enormously magnified in exhibiting, as you all know. The slightest defect in registration is pitilessly magnified, and when the minute defects of registration in the first three pictures are followed by minute defects of another sort in the next three, and by yet another sort in the succeeding three, and so on throughout the length of a film, the effect on the observer is almost unbearable.

A plan much recommended, and much patented, I believe, is to use three lenses in taking the negatives, with a colour filter behind each, and to use a similar contrivance with three lenses and colour filters when projecting, adopting one of the usual contrivances to superimpose the images issuing from the three lenses. Whether the persons who advocate and patent this plan ever descend to the trivial detail of trying it is unknown, but when Mr. Urban and I tried it with carefully made machinery, the results were astonishing and painful to behold. It becomes evident on trial that the three pictures taken through the three lenses, however close the proximity of the latter may be, are slightly different from each other, and the attempt to superimpose these slightly different pictures when they are highly magnified, results in unbearable confusion.

The next idea we worked upon was to abandon the attempt at mechanical registration of the three pictures, and to run the films through the projecting machine at such a speed that the colours on the revolving shutter would combine, and so give the desired effect by persistence of vision. This was successful, but the colours were washy and ineffective. In fact, the colours were so pale that, considering the amount of film used up (three times the usual number of feet per subject), and considering that the problem of exposure was made three times as difficult, the experiment assumed a less hopeful aspect. The death of the original patentee put a further damper on the enquiry, and the experiment finally dropped.

During the last four years I have renewed the enquiry, to the exclusion of almost all other work, with the enthusiastic support and ever buoyant encouragement of Mr. Charles Urban. I have concentrated attention specially upon four points:—1. Sensitizing the film to *all* colour waves, specially pressing the sensitiveness as far into the red end of the spectrum as possible. 2. Superimposing the colour records by persistence of vision. 3. Compressing the colour records into a less number than three, so as to give the least possible interval of time between successive presentations. 4. To conform to the condition that any scheme must be easily applicable to the existing cinematograph machinery, and that the standard film with standard perforations must be used, so that any successful results might be readily adopted by every cinematograph user without much trouble or expense.

The first of these lines of enquiry (sensitizing) has been already referred to; it simply consisted of repeated trials and experiments day by day for a year or more until the required conditions for sensitizing emulsions for cinematograph work were better understood. The third line of enquiry, that of reducing the number of pictures in which the colour waves could be recorded in a monochromatic scale from three records to two,

also resolved itself into a matter of repeated trial. For, in addition to deciding upon the particular shades of grey deposit which should be adopted as the equivalent of particular colours, the variations of different emulsions in yielding these greys had to be taken into account. The final deduction from the experiments under the third heading was that, proceeding from the red end of the spectrum, all rays from dark red to blue could be recorded in proportions which our eyes accept as sufficiently truthful through two filters only.

If we ask individuals to set down the principal colours of nature, placing them in order of luminosity or brightness to the eye, the average of the lists will be as follows:—White, yellow, orange, red, green, blue, violet, indigo, black.

Now reference has previously been made to the unfortunate fact, that photographic plates or emulsions do not see as we do; thus, to the plate, blue and violet come at the top of the scale next to white, and not at the bottom end, as they do in the luminosity scale. I find that it is possible with two carefully-adjusted filters to pass to the sensitised plate or film colours in proportions parallel to the above order. Through one filter I pass white and yellow, then on through orange and scarlet to the darkest red I can sensitize for. Through the other filter I pass white and yellow again, as these two are at the head in luminosity and require fullest representation; then on through green, blue-green, blue and violet in the proportions suggested by the above luminosity list. The aim is to secure, by a careful adaptation of filters to emulsion, a record of colour luminosity stated in gradations of tone from white to black through a scale of greys, this scale being fully represented in two successive pictures.

I take the pictures with an Urban bioscope camera fitted with the required filters to come into action alternately. One film only is used, of the usual standard size, and I take the pictures at the rate of not less than 16 per second through each filter, or 32 pictures per second in all.

When the negative record has been duly developed, and a positive transparency made from it, this positive transparency represents, by its gradations of tone from white to black in each successive pair of pictures, not only a record in form and shape, but it also acts as a filter or sifter of light; for when it is passed in the path of rays of coloured light it will screen or filter them so as to reconstruct for our eyes the various proportions of colour luminosity which were present in the scene when the record was made.

I have said that the photographic record now obtained is to be placed in the path of colour rays, which rays are to be sifted by the travelling record so that the required amounts of colour reach the projection sheet in due proportion. The question now is, What rays of colour are we to use? Apparently, we must use the same colours that we used as filters in the camera, and, in fact, we may do so with pleasing results. But theoretical critics will point out that, owing to the unfortunate over-sensitiveness of the film to violet and blue, we must, of necessity, have cut these colours down to such an extent in our camera that if we use the same filters for reconstructing colour for the human eye, their absence will be sorely missed—our whites will be so deficient in blue and violet, that they won't be white at all, but orange or yellow.

One reply to this contention is, that white is very largely a comparative sensation. What we agree to call white in a painting, for instance, is often quite different from what we agree to call white in another painting if we take steps to compare the two "whites" with one another. One may be yellowish or greyish compared with the other, yet both are white enough in their proper place in the picture, when surrounded with colours in proper "key," as it were to them. Again, the whitest of paper will look yellow when compared with the purer white of fresh fallen snow. Therefore, our whites produced by the mixture of coloured lights may possibly be somewhat yellow as a matter of spectroscopic reality, but if the human eye accepts them as white by comparison with other colours in the same picture we need scarcely bother our heads further.

But another way of meeting the critical objection that the analytical filters of our camera are necessarily too deficient in violet and blue to give a proper rendering of colour when used as synthetical or reproduction filters in projection is to introduce the missing beams of violet and blue into our projection instrument, and so make ourselves practically secure of the white or "all-colour light," required on theoretical grounds. This I find it an advantage to do; and if you examine the light emanating from the projecting machine when lighted up and at work, you will see that beams of red and green are alternately issuing from the lens, and that these beams have

added to them by means of a supplementary shutter just those proportions of violet and blue required to make a pure white when all are mixed. Thus we have light on the sheet for our whitest objects which contains, as it should contain to conform to theory, every colour of the spectrum from dark red to violet.

There are some persons so obsessed with the idea that three is the magic number for filters, that they imagine a system in which two only are employed must necessarily restrict the colours recorded and reproduced to two. There is in fact a good deal of confusion on the subject of colour mixture, and there are not a few who argue as though mixing coloured lights and mixing coloured pigments were the same thing. No mixing together of two or more pigments will ever make white; but white light can be produced by the mixture of two correctly chosen coloured lights. The printer who has to make colour prints on paper certainly has to divide the spectrum into three or even four, but he is dealing with printer's ink or paint, not with light at all. Every writer on the phenomena of light, including Tyndall and Sir Henry Trueman Wood, teaches that white light can be made by the proper mixing of two well-chosen coloured lights; and it is further taught by every authority that white light contains all colours. I hope, however, to *demonstrate* that by dividing the spectrum into two it is possible to exhibit satisfactorily every colour to the eye, including the purest of white.

The practical method sketched above is possibly open to assault on strictly theoretical grounds—although it must not be forgotten that theories have sometimes to be re-examined in the light of facts. The first consideration to my mind is the production of results. I am not striving to defend a theory; nor do I deem it necessary to keep within the limits of a theory.

I have no doubt whatever that many improvements are in store. Lens makers, emulsion makers, mechanics, will each contribute to the advance. I expect to make important improvements myself when Spring comes and I renew my experiments. The present results are presented as early experiments in the photography of moving things in colour, and as the first serious exposition of work done in that direction. It is to be hoped that the numerous others who, we are led to believe, are working in the same direction will be encouraged to put their theories to the test and come forward with their results.

In conclusion, I submit the reasonable proposition that just as we have seen great advances in animated photography in black and white since the popular advent of the art nearly fourteen years ago, when there were numerous difficulties and limits which have gradually been overcome or broken down, so we shall see great and rapid advances in the new art of recording and reproducing moving scenes in natural colours. My own efforts, now briefly described and illustrated, will, I hope, inaugurate the movement, even if future results are obtained on quite different lines. As I have said, the first consideration is the production of results, and the results of my own researches we will now proceed to examine, with the assistance of Mr. Charles Urban and his bioscope.

DISCUSSION.

Sir Henry Trueman Wood (Secretary of the Society) thought the subject of the paper was not one which lent itself to discussion in a large and general audience, but he felt it would be a pity if somebody who had studied and worked at the question of coloured photography did not draw the attention of the meeting to the scientific interest and value of the very beautiful experiments which had been shown. Even an individual without any knowledge of photography was, he was sure, able to appreciate the beauty of the pictures, and the great advance which had been made in kinematography, but it required a little special knowledge before one could appreciate the full merits of the invention. The first point of interest was the way in which "persistence of vision" was utilised to produce colour, as well as movement, and the difficulties of perfect registration thereby avoided. The second point was the substitution of two colours for three. It was easy to understand how it was possible with three colours to represent to the human eye the whole range of colours of the spectrum, but he did not think even those who were most familiar with the subject were able to explain how it was that such good results were obtained with two colours. The only criticism he ventured to offer was, that it seemed to him that, while the reds were admirably rendered, the darker blues, and some of the greens, were not quite as true to nature as theoretically they might be, but, no doubt, that was a matter which would be improved in the future. Even if Mr. Smith progressed no further than he had done, he had made a very valuable addition to the list of photographic inventions. He was very much confirmed in his view by the fact that those colours which required the greater part of the range of the spectrum to represent them, the greys and browns, appeared to him to be admirably and

perfectly truly rendered. For instance, the grey of the donkey shown appeared to be perfect; and it was a very well-known fact that the most difficult colour to reproduce by means of three-colour photography, was a grey or a white. The brown of the horses also struck him as being absolutely true to nature. Another point of merit, which he thought ought to be placed on record, was the extreme sensitiveness of the film which the author had obtained. Speaking as an old photographer, he found it hard to realise that a detailed picture could be obtained through a red screen with an exposure which was actually less than a 50th of a second. A great amount of credit was also due for the beautiful mechanism, which was able to stop the film and hold it stationary for the minute portion of time during which the light was allowed to act upon it, and to repeat the operation 2,000 times in a minute: it reflected very great credit both on the mechanical as well as the chemical skill shown. He wished to express, on behalf of the Society, the great satisfaction all present felt at having seen Mr. Smith's wonderful pictures; and he thought their earnest thanks were also due to him, not only for showing them, but also for the very candid and full way in which he had explained in the paper, which contained a record for future use of practically the whole of his invention, the manner in which those marvellous results had been obtained.

The CHAIRMAN, in proposing a most hearty vote of thanks to Mr. Smith for his admirable paper, thought that the audience must feel they were highly privileged to be present on the very first occasion that such marvellous results of patient industry and remarkable talent had been set before the public. He was much impressed by the fact that the films shown were not taken in a continuous stream, but that each picture on the films was taken separately, a fresh start having to be made after each separate picture was taken. It was simply marvellous to think that the film was not being sent through at a certain rate, but that the machine was stopping and going on again thirty-two times a second. He was sure it would be Mr. Smith's wish that mention should be made of Mr. Urban, who was associated with him in the production of animated pictures in colours, and to whose assistance a large share of the interest of the paper was due. Mr. Albert Smith's name struck a very pleasant note in his memories of the past, but the celebrated view of Cologne Cathedral at midnight shown by that eminent popular entertainer was very different from the brilliant views exhibited that evening by the living bearer of the name.

The resolution of thanks was then put to the meeting and carried by acclamation.

Mr. ALBERT SMITH, in reply, after expressing his extreme gratitude for the cordial way in which his paper had been received, said he greatly appreciated the words which fell from the lips of Sir Henry Trueman Wood, who knew as much about the subject as anybody present. Reference had been made to the mechanical skill which was required to construct the camera with which the experiments were made. That camera had been made under the supervision of Mr. Charles Urban in his works, and that gentleman was entitled to the sole credit for the production of that apparatus.

TURKISH MINERAL SPRINGS.

Among the mineral springs in vogue in the vilayet of Smyrna are those at Tchesme, which are visited more than any others. From all parts of the Turkish Empire, invalids come in large numbers to take the waters, which are sulphurous and saline, with a temperature of 135° Fahrenheit. They are highly recommended for rheumatism and skin diseases. Within seven miles of Smyrna, are the hot springs of Lidja, which were known to the ancients under the name of the Baths of Agamemnon. They are used for rheumatism. Between the springs of Tchesme and Lidja is a spring of saline waters very similar to those of Carlsbad, much used as a cure for liver complaints. The district of Pergamus boasts of several hot springs, the last known of which is at the village of Kinik. There are also hot springs in the district of Kouch Adassi which, according to the American Consul at Smyrna, are popular locally. Three miles south-east of the ruins of Sardes, the hot springs still exist which were so renowned in ancient times. They are now little frequented, owing to their isolated position in the mountains. At Alacheir, a native company is bottling the water of the Sarikiz spring, which is said to be much appreciated, and which is now being exported in ever increasing quantities. So much is this water now being used in Smyrna and other cities in Turkey, that European mineral water is said to have fallen off in consumption in consequence. Several hot springs are situated near the city of Aidin, some of which have the reputation of healing wounds. All the waters of the Lycus valley are mineral, and some of them are thermal. Those of Hierapolis are still visited by the native population in great numbers. This Hierapolis spring ranges in temperature up to 190° Fahrenheit. All the mineral waters of this valley have incrustating properties. According to a recent circular issued by the competent authorities, permission to exploit mineral springs in the vilayet of Smyrna, of whatever kind, will be granted after analyses have been made, to those who offer the highest royalties to the State.

THE FRENCH DAIRYING INDUSTRY.

In the neighbourhood of all the cities of any size throughout France dairying efforts were formerly made with a greater or less degree of success, and it is but recently that larger interests are creating

centres for the production of milk, butter, cheese, &c. There have consequently been numerous experiments in removing milch cattle from one part of France to another, to see if they adapted themselves readily to new surroundings. For instance, it has been found that the Normandy cow brought to the neighbourhood of La Rochelle loses to a certain degree her excellent qualities as a butter maker, while those from Brittany maintain the excellent reputation they have at home. The American Consul at La Rochelle says that the Parthenay breed of cattle is, perhaps, the most remarkable for butter producing. It is generally conceded in the district of La Rochelle that it is necessary to average 17 litres (15 quarts) to produce 1 kilogramme (2·2 pounds) of butter. This was already considered an excellent showing, but in the competitions of 1905 and 1906 milch cattle of the Parthenay breed gave remarkable results. The competition of 1907 was equally interesting, the first prize being awarded to a cow whose milk produced 1 kilogramme (2·2 pounds) for each 11 litres (about 10 quarts). The industry is proving profitable for the enterprising dairyman, who carefully selects his animals, and organises his pasturage in such a manner as to permit his meadows to take on new growth after they have been carefully browsed over by his cattle. In the Pyrenees it appears that a litre (1·76 pints) of milk sells for an average price of twopence. At this price the keeping of cattle is considered lucrative. Dairies are being established very rapidly in the district of La Rochelle, and the butter of Surgères, made after the most improved methods, is rapidly replacing on the Paris market Dutch and Belgian butters. In fact, demand for dairy products of this district is very much greater than the supply, and the larger cities are all the time calling for more. Experiments are being conducted with several breeds of cattle in order to learn their value as butter producers.

IRON AND STEEL WORK IN THE UNITED PROVINCES OF INDIA.

The Indian Government monographs on the different industries, carried on in various parts of the country, are generally very interesting, and a recent note by Mr. W. E. J. Dobbs, I.C.S., contains some facts and suggestive notes on the metal industry in the United Provinces. The number of workers is not large—only 23,000—and many of them till the soil also. The tradition of the Mohammedan *lohars*, or smiths, is that Daud (David) was the inventor of iron-work, and that iron miraculously became as wax in his hands. He sold articles of ironware to gain a living, and from his day, iron has been in use. Accordingly, they invoke him before beginning any task, and burn incense in his honour on Thursdays. Nevertheless, the *lohar's* social position is a low one, and there is nothing of a harmonious or picturesque association with his calling, as in the West. As a class, too, the *lohars* are very illiterate, but there are possibilities of a greater future before them, as the use of iron vessels, for domestic purposes, is increasing fast, while the advance made in the imports of machinery into towns, and even villages, will necessitate the employment of a great company of smiths and fitters. One of the pressing industrial problems of the day, in India, is how to meet the large and increasing demand for skilled mechanics. In the western districts, and in Bundelkhand, are found gangs of wandering smiths, who, like English tinkers, wander about from place to place with their families, goods, and chattels, in quaint-looking carts. They claim to be descended from Rajputs of Chittore, who, when the Mughals sacked that city, took to a wandering life, and vowed they would never settle elsewhere, but would make weapons of war, till Chittore recovered its former glory. Under the Pax Britannica and the Arms Act, they have been compelled (literally) to beat out ploughshares, instead of swords.

Some of the *lohar's* expressions have a general currency as proverbs. "To chew iron gram (or grain)" has much the same meaning, as to "cut through adamant," with us. "Iron strikes iron" (*Lohe ko loha marta hai*) is an equivalent expression to "diamond cuts diamond," and "cold iron cannot be straightened by hammering" means much the same as "ploughing the sand" in English. In contrast to our superstition, it is regarded as unlucky to find a horseshoe; while Mohammedans believe that they can injure an enemy by writing his name on a horseshoe, and then putting it in a fire.

The manufacture of arms was of some importance in these provinces before the days of British rule. The various chiefs and their retainers had to be provided with weapons, and probably every town and castle of importance had its armourers of sorts. Agra had some repute in the manufacture of chain armour and weapons of war, while Delhi swords made of imported steel (*faulad*) were held in the highest regard. The three main heads, however, under which swords were generally classified, were Vilayti (imported), Asils (the renowned blades of Gujrat), and Khanasaz (of domestic manufacture). At the present day there are not more than half-a-dozen sword makers in the provinces, inclusive of two or three at Rampur and of the Maharajah of Benares' armourer. The manufacture of matchlocks survived into very recent times, and some of those made to order were exhibited at the Paris Exhibition of 1867, and obtained a prize of 750 francs, others being readily sold. One was also exhibited at the Calcutta International Exhibition of 1883. European firearms of modern type are accurately and skilfully copied by clever *lohars* at Rampur and Bareilly. In respect of cutlery, the most important industry in the provinces is that of the scissors makers of Meerut, whose goods enjoy a wide reputation and have a hold on the market, their price being lower than that of the American article.

By far the greater number of the iron-workers are employed in making ploughshares and other agricultural implements, or such homely domestic neces-

saries as cooking vessels, buckets, and sieves, the latter industry being carried on in places of some size or local importance.

A NEW MATERIAL FOR CINEMATOGRAPHIC FILMS.

With reference to the article entitled "A Substitute for Celluloid," which appeared on pages 1009 and 1010 of the *Journal* for the 16th October last, the following further details in regard to "cellit," the substitute in question, more especially in connection with the use of cinematographic films, may be of interest. Cellit is the trade name for a form of acetyl-cellulose. It is possible to prepare a variety of these acetyl derivatives of cellulose or acetates with varying properties, exactly as is the case of the analogous nitrates of cellulose — gun-cotton, pyroxylin, collodion, &c. The United States Consul at Chemnitz, who has obtained his information from the inventor of cellit, says that the acetates first obtained during recent years yielded, in combination with camphor, more or less brittle substances. Their only satisfactory solvents were chloroform and acetylene-tetrachlorid. The narcotic action of the first solvent and the poisonous nature of the latter, rendered their use most objectionable. These disadvantages, in addition to the brittleness, effectually prevented any practical use of the earlier forms of acetyl-cellulose for use in the cinematograph, although numerous experiments in this direction were carried on for a long period. The newly-discovered modification, in its camphor derivative termed cellit, is said to possess the required properties, missing in its homologues. It is the reverse of brittle, resembling leather, and it is readily soluble in the comparatively cheap mixture of alcohol and acetic ether (ethyl acetate). With these two all-important properties to start with, much study and many experiments were required before a cellit was secured, meeting all the many demands for cinematographic films. Celluloid (the combination of camphor and gun-cotton) is characterised by its hardness, springiness, and tenacity. Many difficulties in this connection were gradually overcome, until cellit films were finally prepared free from liability to tear, or stretch, or crumple. In the cinematographic apparatus there is now no scratching of the surface, no tearing, no distortion on the part of cellit films when swiftly passed through the mechanism. The various other technical difficulties in connection with the application and fixation of the sensitive emulsion, the securing of uniform transparency, &c., have all been successfully met, so that the new films are scarcely to be distinguished from celluloid preparations, so far as lustre, tenacity, evenness, transparency, &c., are concerned. In one respect, however, there is the most striking and important difference, and that is inflammability. When celluloid is brought near a source of heat, it instantly takes fire, burning with a large crackling flame, which spreads so rapidly that all possibility of extinction is practically precluded. On the other hand, when a burning match is applied to a cellit film, it does not take fire at once, but only after an interval. Then a slow combustion, accompanied by a small flame begins, and is gradually propagated through the mass, very much as in the case of a sheet of india-rubber. A cellit film behaves much as a stick of sealing wax. It tends to melt, and while the molten substance falls down in drops, the flame is often extinguished. While cellit films, in contact with a flame, exhibit such a measure of slow combustibility, they are entirely incombustible in the cinematographic apparatus. Even when exposed to the concentrated rays of the most powerful arc lamp, there is said to be no sign of combustion. When the exposure is prolonged, changes become evident in the film; the layer of emulsion is loosened, blisters appear, there is a general shrinkage, and finally fusion begins along the lines of the photographic picture. The action ceases with this result, even if the exposure be maintained for an hour. The behaviour of a celluloid film, under such conditions, is all too well known. It is impossible to adjust it in the apparatus without full protection from the source of light. If exposed for a second it begins to smoke, and within a very short time it bursts into flame. This unfortunate property has rendered the cinematograph such a source of danger, when through any accidental interruption of the rapid movement of the celluloid films before the powerful sources of light, or even through the tearing of a film, instantaneous combustion ensues. Preventive measures designed to lessen the danger have been taken in various countries by the police authorities, and are of the most manifold variety. There are requirements for the enclosure of the apparatus in a fireproof cell during an exhibition, for its operation in a room covered with asbestos, outside an exhibition hall, for the use of asbestos clothing by the operators, for the entire absence of flame-giving light, &c.

Numerous attempts have been made to replace celluloid as a material for films. Gelatine has been tried in a multitude of forms. Its lack of strength and its tendency to swell up in developing baths have prevented any practical application for the purpose. Even when enclosed between exceedingly thin sheets of celluloid it fails to withstand the effects of the bath. Other albuminous bodies are lacking it is said, in plasticity and transparency. Attempts to replace camphor in the manufacture of celluloid by less combustible organic substances, or by noncombustible mineral bodies, have totally failed to yield a material adapted for use as films. It is to be hoped that, after the very exhaustive tests to which cellit films have been submitted by the German manufacturers of cinematographic appliances, the problem has finally been solved in a manner which will remove all elements of danger from this popular and instructive form of exhibition.

HOME INDUSTRIES.

The Port of London Bill.—There is now ground for hope that the Port of London Bill, which was read a third time on Tuesday, will become law before Parliament adjourns. On Friday last the Bill passed through committee, and was reported to the House of Commons. It was recommitted for consideration of a new clause which has evoked considerable criticism. It embodies an innovation upon established practice in that it enables the Port Authority to do, in virtue of an order of the Board of Trade, various things for which it has hitherto been necessary to get the direct authority of Parliament by means of a private Bill. Whenever there is an extension of existing works, or whenever land is required for the erection of new works, it will afford a more cheap and expeditious way of acquiring land than is at present possible. It is not surprising that a proposal of this kind met with considerable criticism from both sides of the House. It was argued that it gave the Board of Trade powers that no public Department has ever yet possessed, and that ought only to be vested in Parliament. But the Port Authority is not to be an undertaking carried on for private profit: it will really have the character of a great public Department, and may accordingly be held to deserve treatment different from that given, say, to a railway. Nor can it be denied that the existing system, by which an undertaking like a railway cannot acquire compulsorily the smallest patch of ground without the great expense and worry of a private Bill, is not to the public advantage. The Chancellor of the Exchequer, defending the proposal to give the Board of Trade the power to dispense with the need of access to Parliament when the suggested transaction is comparatively small, went so far as to say that "very often proceedings upstairs (in matters of private Bill legislation) were blackmailing proceedings, and were fought simply to get a big price from the company promoting a Bill. Parliament ought not to be a sort of huge blackmailing machine for the purpose of extracting extravagant fines from great commercial and industrial enterprises. Huge railway rates were being now largely paid as a result of the railway companies being compelled to come to Parliament every time they needed power to build a station for the convenience of the public, or to form a crossing, or widen their line." The Government did not, however, propose that the Board of Trade should be the sole judge as to whether compulsory powers should be exercised or not. It must appoint an impartial person to hold an inquiry, and, as a result of last week's discussion, the Government agreed that a Board of Trade order shall not take effect until a draft thereof has lain for thirty days on the tables of both Houses of Parliament; and if either House during those thirty days presents an address to His Majesty against the draft, no further proceedings shall be taken thereon. The compulsory powers of the Board of Trade are also to be limited, so that beyond a certain value, or extent, of purchase it shall not have compulsory powers. This new departure in the administration of the Port of London will be a great experiment, and, although expert opinion is divided upon its probable effect upon the Port, the balance of opinion would seem to be in favour of the Bill.

The Shipbuilding Trade.—In September there was an unexpectedly large number of new contracts booked, or reported, amounting in all to about 120,000 tons. This estimate, however, included five steamers, said to have been booked by the Russian Volunteer Fleet, an order afterwards transferred to German builders, who offered longer credit. Even then, the Clyde September contracts aggregated 100,000 tons, and another 50,000 tons were booked in the various English districts. But in October and November the new contracts booked were comparatively few. If the output of the Clyde, for the eleven months ended November of the present year, is compared with the corresponding period of 1907, it will be found that there has been a decrease of no less than 217,409 tons—the smallest output since 1897. The Clyde total for 1907 was 619,919 tons, and the actual launches for 1908 to date have been only 315,205 tons, so that this year's output from the river may be expected to be a quarter of a million tons less than last year. The production of the English yards has fallen off in similar degree, and it is not surprising to hear of great depression and distress in the North when the amount of material and wages involved in this shrinkage are remembered. The allocation among private builders of Admiralty orders for cruisers and destroyers, will give employment to three or four yards, but does not help the great bulk of yards, which are only fitted for the production of merchant vessels. There is not likely to be much, if any, improvement in the position until the new year, but some authorities are of opinion that, with its advent, things will begin to mend.

The Tin-plate Industry.—It is a remarkable fact that whilst nearly all the industries of the United Kingdom have suffered, many of them very seriously, from this year's great reaction in trade, the tin-plate industry has held its own. In the ten months ended of 1907, of 600,000 tons. The decrease in wrought October 31st last, the export of pig-iron shows a decrease, as compared with the corresponding period iron was 38,000 tons; in galvanised sheets 85,551 tons; in chains and sleepers 8,436 tons; in ship, bridge, boiler, and other plates not under $\frac{1}{8}$th inch thick 71,767 tons; in ship and boiler plates under $\frac{1}{8}$th inch thick, 6,854 tons; in wrought tubes, pipes, and fittings, 4,670 tons; but the exports of tin plates amounted for the ten months to 338,117 tons, as compared with 337,907 tons in the corresponding ten months of last year. It is true that the increase is very slight, only 210 tons, or less than 1 per cent., and that there has been a decline in values of nearly 7 per cent.; but the fact remains that in volume the export trade in tin plates is greater than it was for the

corresponding period of last year. This comparatively satisfactory state of things is due in no small measure to the harmony existing between employers and employed. The relations of master and workman in the South Wales tin-plate trade are seldom disturbed over questions of wages, or conditions of employment, with the result that mutual confidence secures for the industry a measure of stability of the greatest value to the manufacturers in booking orders for future delivery. Of course, the fall in the prices of coal, pig-iron, tin, and steel bars, the chief raw commodities of the tin-plate industry, have been important factors in the maintenance of the prosperity of the trade, since they have cheapened the cost of production, but these and other factors, such as the steady absorption of smaller works by the larger firms, would not have sufficed to maintain the volume of exports if labour relations had been other than they have been.

Insurance Developments.—Reference was recently made in these Notes to the action of a leading insurance company in notifying its intention to open a department for the insurance of loss of profits arising through the disturbance of business by fire. Other great companies have now decided to follow the example set by the Alliance, and it seems likely that before long all the leading companies will transact this kind of business. There is evidently a demand for this protection, and extended facilities, certain to be offered, will stimulate it. Another development in insurance business is the undertaking by insurance companies of the duties of trustees and executors. Long before the appointment of the Public Trustee, the voluntary system was felt by many to be too great a burden. It may be said that the Public Trustee now meets the want, but many distrust Government departments, believing them to be unnecessarily cumbrous and costly, and would much prefer to have their estates in the hands of an insurance company of known stability and honourable traditions.

The Miners' Bill.—The prospect of this much debated measure passing into law, at any rate without substantial modification, does not improve. Indeed the opposition to it seems to grow more general and vehement as the time approaches for it to leave the House of Commons. Mr. Russell Rea, M.P., the Chairman of the Departmental Committee, has stated that the Bill as it leaves the Committee is "even worse than it was when submitted to it;" the Chambers of Commerce condemn it on the ground that it must result in an increase in the price of coal; and there is strong opposition from the various coal-consuming industries in the country. It is urged that it would be disastrous to saddle trade with additional burdens, especially seeing that it has now been ascertained that miners, in the way of health and physique, compare favourably with other occupied males in the country. It said by some that legislative interference with existing conditions would result in the shutting down of the majority of the Staffordshire mines, and would prejudice the workings in other parts of the kingdom. Of course, there is much to be said on the other side of the question, and in defence of the Bill, but the Home Secretary himself has admitted that he is not without some apprehension as to the possible effects upon trade if it becomes law in its present shape, and, having regard to the volume of dissent indicated above, it is very unlikely that the measure will go through the Lords, if it is allowed to go at all, without amendments of a drastic character.

NOTES ON BOOKS.

A History of Art. By Dr. G. Carotti. Volume I. Ancient Art. Revised by Mrs. Arthur Strong, Litt. D., LL.D. London: Duckworth and Co. 8vo. 5s. net.

This work has been translated by Miss Alice Todd from the Italian of Professor G. Carotti. Mrs. Strong's responsibility begins and ends with the assistance she has rendered to the translator in some of the archæological passages, and in the rendering of certain names. The book contains a lucid picture of the history of ancient art as revealed by modern research. An immense amount of information has been compressed into the volume, but brevity has not been obtained at the cost of lucidity. In these 350 pages is set forth a concise account of ancient art from the Memphite period (about 5,000 to 2,500 B.C.) to the later Roman age, while a brief Appendix gives a slight sketch of Indian and later Persian art. A fresh bibliography has been specially compiled for this edition, and this should be of great service to persons beginning to study the subject, who will also learn much from the five hundred illustrations contained in the volume.

Recollections of a Life in the British Army. By General Sir Richard Harrison, G.C.B., C.M.G. London: Smith, Elder and Co. 8vo. 10s. 6d. net

Lieutenant Richard Harrison, R.E., first saw active service under Sir James Outram in 1857. He fought his way through the thickest of the Indian Mutiny, and afterwards served through the China war of 1859-60, the Zulu war (when he was closely associated with the ill-fated Prince Imperial), the Sekukuni war, and the campaign against Arabi Pasha. With such a record he has naturally much to tell. Throughout his adventurous and distinguished career he has had a keen eye for men and things, and as he possesses a brisk, vivid style, his story is eminently readable. He has certainly been well advised in changing his original intention, which was to publish these notes for private circula-

tion only; and no doubt he will be justified in the hope that what he has written will prove interesting not only to his personal friends and relatives, but to a larger circle of the reading public.

DIVISIBILITY OF SILK FIBRE. By Sir Thomas Wardle, J.P. Manchester: John Heywood, Ltd., 8vo.

This book consists of two parts: the first is an examination by Sir Thomas Wardle into the divisibility of the brin, or ultimate fibre, of the silk of *Bombyx mori*, or silk of commerce, and of some wild silks; the second is a translation of a report of an investigation on a similar subject carried out under the auspices and in the Laboratory of the Studies of Silk, Milan. The author's attention was first called to the study of the subject by a silk manufacturer, who sent him a skein of dyed silk which was marred by the defect known as "speckiness." Several theories have been advanced to explain this phenomenon. Some persons believed it to be due to a defect in the reeling, throwing, or manufacture; others attributed it to a microbe, while some even ascribed it to an abnormal appetite and digestion in the silkworm, which caused it to emit, contemporaneously with the fibres or brin, incompletely digested vegetable matter. Sir Thomas's investigations have led him to believe that the specks are "simply a tangled rabble of filaments split off or exfoliated from the original fibre or brin." The question is one of practical importance to silk manufacturers, and the excellent illustrations contained in the volume should be of service in elucidating the problem.

OBITUARY.

VEERCHUND DEEPCHUND, C.I.E.—Mr. Veerchund Deepchund died last month at Ahmedabad, at the age of 76. Born in humble circumstances he rose to a position of wealth and influence in the mercantile world of Bombay. His charity was unostentatious but extensive, especially during the famines of 1877 and 1897. He was created a Companion of the Indian Empire in 1898, and became a member of the Society of Arts in 1900.

GENERAL NOTES.

AERIAL WARSHIPS.—At the discussion of Mr. Eric Stuart Bruce's paper, "Mechanical Flight," Sir Hiram Maxim asked "if anyone doubted that in case of war a strong Continental Power would use flying machines for bombarding English towns." A representative of the *Daily Graphic*, who had the opportunity of talking with a scientific chemist on the powers of explosives, was rather astonished to find that the destructive effect in warfare of the best airships is a matter of considerable doubt to those most aware of the powers of modern explosives. Sir Hiram Maxim has supposed that a fleet of airships, or even a few airships, could dominate and destroy a town by sailing over it and dropping on its buildings and arsenals packages of high explosives. "But," said the authority, "such an assumption appears to neglect the conditions under which high explosives become effectively dangerous. No doubt if an airship dropped a few pounds of dynamite in Piccadilly the explosion would cause considerable inconvenience—especially to a policeman or a cab-horse in the immediate neighbourhood of the explosion—but it would not wreck the thoroughfare. Nor would any known or probable explosive. For disastrous explosions some restraining chamber or cavity is needed, and even a hundredweight of dynamite, unless exploded in a confined space, could not effect widespread destruction. What does make an explosive effective is wrapping it up, so to speak, in a steel chamber or receptacle from which the expanding gases cannot instantly escape. The effective power of a bomb lies not so much in the mere force of the explosive material as in the bursting of the heavy metal shell which surrounds it. To enclose a high explosive in a very light casing is to destroy its powers of destruction from a military point of view. In support of this view we have the opinion of M. Canet, Director of the great works at Creusot. And if, therefore, the airships of the future have to carry as much ammunition as a *Dreadnought*, how are they to float? They could not 'keep the air' at all—in fact, they could not rise in it."

BRITISH TRADE WITH MOROCCO.—In his report on the trade of Tangier, just published (No. 4167, Annual Series), Mr. Consul McLeod refers to the decrease of British steamers carrying passengers or cargo from Tangier direct to the United Kingdom. The British services from Gibraltar continue as before, two British steamship lines running thrice weekly each way, but, unfortunately, on the same days, which days are those on which the Spanish steamers also make their voyage; but no British line sails from Tangier direct for the United Kingdom. It is to be hoped that some British steamship company may find it worth while to provide a direct regular service from Tangier to the United Kingdom for passengers and cargo. At present the only service of this kind is that of the German East African line, a vessel leaving every three weeks from Hamburg *viâ* Lisbon and Dover. Although British trade has suffered from the political unrest in Morocco, it is satisfactory to note that it has suffered less than that of other countries. The effect of the disturbed state of affairs is strickingly illustrated by the fact that there were five pilgrim steamers in 1906, but only one in 1907, and only seven exclusively tourists' vessels in 1907, as against thirteen such steamers in 1906. There were five German tourist vessels in 1906, but none in 1907.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evening, at 8 o'clock:—

DECEMBER 16.—"London Milk Supply from a Farmer's Point of View." By PRIMROSE MCCONNELL, B.Sc., F.C.S. SIR GEORGE BARHAM, J.P., President of the British Dairy Farmers' Association, will preside.

CANTOR LECTURES.

Monday evening, at 8 o'clock:—

OSCAR GUTTMANN, M.Inst.C.E., F.I.C., F.C.S., "Twenty Years Progress in Explosives." Four Lectures.

LECTURE IV.—DECEMBER 14.—Use of nitrocellulose for celluloid, artificial silk and varnish—Machinery driven by explosives—Factories, their inspection, construction and accidents—Precautions recommended — Electric lighting — Static electric charges—The merits and demerits of explosives—Stability and its proof—Stability in practice—Accidents with smokeless powder — Stabilizers — The powder of the future.

JUVENILE LECTURES.

Two Lectures, suitable for a Juvenile audience, on "Digging for Ancient Art Treasures," will be delivered by PROFESSOR CHARLES WALDSTEIN, Litt.D., Ph.D., on Wednesday afternoons, January 6 and 13, 1909, at 5 o'clock.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 14...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. O. Guttmann, "Twenty Years Progress in Explosives." (Lecture IV.)

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. (Graduates' Section.) Mr. Reginald Bishop, "Commercial Precision Grinding."

Geographical, Burlington-gardens, W., 8½ p.m. Sir William Garstin, "Fifty Years of Nile Exploration and some of its results." (The Jubilee of Speke's Discovery of the Victoria Nyanza.)

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. W. Bateson, "Mendelian Heredity."

TUESDAY, DEC. 15...Faraday Society, in the Library of the Inst. of Electrical Engineers, 92, Victoria-street, S.W., 8 p.m. 1. Dr. F. J. Brislee, "The Redetermination of the Electrolytic Potentials of Silver and Thallium." 2. Messrs. F. E. Weston and H. R. Ellis, "The Heats of Combustion of Aluminium, Calcium, and Magnesium." 3. Mr. H. Russell Ellis, "The Formation of Graphite by the interaction of Magnesium Powder and Carbonates." 4. Dr. Ernest Feilmann, "Colloidal Barium Sulphate."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. Edward Henry Tabor's paper, "The Rotherhithe Tunnel."

Royal Statistical, 9, Adelphi-terrace, W.C., 5 p.m. Mr. Samuel Chapman, "American Methods of Railway Accounting."

WEDNESDAY, DEC. 16...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Primrose McConnell, "London Milk Supply from a Farmer's Point of View."

Meteorological, 25, Great George-street, S.W., 7½ p.m. 1. Mr. Eric Stuart Bruce, "Some Forms of Scientific Kites." 2. Mr. C. J. P. Cave, (*a*) "The Registering Balloon Ascents of July 27—August 1, 1908." (*b*) "Balloon Observations at Ditcham, July 27—August 2, 1908."

United Service Institution, Whitehall, S.W., 3 p.m. Captain A. H. Trapmann, "The Cycle in Warfare: Its Potency as a Strategical and Tactical Force."

Junior Engineers, at Royal United Service Institution, Whitehall, S.W., 7½ p.m. Mr. Eric F. Boult, "Motor Omnibuses."

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Mr. J. E. Stead, (*a*) "A Workshop Microscope for the Examination of Opaque Objects"; (*b*) "A Simple Method of Illuminating Opaque Objects." 2. Rev. Eustace Tozer, "Mounting Rotifers and Protista in Canada Balsam."

THURSDAY, DEC. 17...Royal, Burlington-house, W., 4½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. W. Riddell, "The Anomura of the Red Sea." 2. Mr. R. P. Gregory, "Forms of Flowers in *Waleriána dívica*." 3. Prof. A. Gruvel, "Etudes sur les Cirrhipèdes du Cambridge Museum." 4. Mr. W. L. Distant, "Rynchota from the *Sealark* Expedition."

Antiquaries, Burlington-house, W., 8½ p.m.

Chemical, Burlington-house, 8½ p.m. 1. Mr. J. E. Reynolds, (*a*) "Silicon Researches. Part XI. Silicotetrapyrrol"; (*b*) "Silicon Researches. Part XII. Action of Silicon Chloroform on Potassium Pyrrol"; (*c*) "Silicon Researches. Part XIII. Silicon Halides and Pyridine, Acetonitrile, &c." 2. Mr. V. H. Veley, "The Affinity Values of Tropine and its Derivatives."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. W. H. Garrison, "Outposts of the British Empire."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Messrs. W. Cramp and B. Hoyle, "The Electric Discharge and the Production of Nitric Acid."

Historical, Lecture-hall, Field-court, Gray's-inn, W.C., 5 p.m. Rev. H. J. Dukinfield Astley, "The Murailles Politiques of the Franco-German War."

Optical Society, 20, Hanover-square, London, W., 8 p.m. 1. Mr. H. S. Ryland, "The Optical Lantern — its use for Entertainment and Teaching." 2. Mr. S. D. Chalmers, "Some Optical Illusions." 3. Mr. J. B. Reiner, "Dr. Edridge Green's Colour Perception Lamp."

Concrete Institute, the Royal United Service Institution, Whitehall, S.W., 4½ p.m. Mr. William Dunn, "The Examination of Designs for Reinforced Concrete Work."

FRIDAY, DEC. 18...Art Workers' Guild, Clifford's-inn-hall, Fleet-street, E.C., 8 p.m.

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. Mr. L. A. Legros, "Typecasting and Composing Machinery."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. R. Wolfenden, "High-power Water-turbines on Moderate Falls."

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FRIDAY, DECEMBER 18, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

CANTOR LECTURES.

Mr. OSCAR GUTTMANN, M.Inst.C.E., F.I.C., F.C.S., delivered the fourth and last lecture of his course on "Twenty Years Progress in Explosives," on Monday evening, 14th inst.

A vote of thanks to Mr. Guttmann for his course of lectures was carried unanimously, on the motion of the Chairman, Sir BOVERTON REDWOOD, D.Sc., F.R.S.E.

The first lecture will be published in the next number of the *Journal*.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience, will be delivered on Wednesday afternoons, January 6th and 13th, at 5 o'clock, by Charles Waldstein, Litt.D., Ph.D., Slade Professor of Fine Art in the University of Cambridge, on "Digging for Ancient Art Treasures."

Each Member is entitled to a ticket admitting two children and an adult.

A sufficient number of tickets to fill the room will be issued to Members in the order in which applications are received.

Members who desire tickets for the course are requested to apply for them at once.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1s. 6d. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

FIFTH ORDINARY MEETING.

Wednesday, DECEMBER 16, 1908; SIR GEORGE BARHAM, J.P., President of the British Dairy Farmers' Association, in the chair.

The following candidates were proposed for election as members of the Society:—

Agarwalla, Rai Girdhari Lal, B.A., 18, Edmondstone-road, Allahabad, U.P., India.
Avery, Thomas, M.Inst.N.A., R.I.M. Dockyard, Bombay, India.
Brown, Duncan Campbell, Bank of Scotland-house, Oban, N.B.
Deacon, Edward, Pentillie, Leopold-road, Wimbledon-park, S.W.
Drewery, Fred. W., Winnipeg, Manitoba, Canada.
Francis, Gabriel Joseph, P.W.D., Chindwin Division, Monywa, Burma, India.
Herringham, Mrs. Christiana, 40, Wimpole-street, W.
Höveler, Herbert Frederick, 45, Christchurch-road, Streatham-hill, S.W.
Leonard, Edward F., Amherst, Massachusetts, U.S.A.
Lomas, Harold M., Alcombe-Dunster R.S.O., Taunton.
Luce, Very Rev. Father Eugene, Clergy-house, Rangoon, Burma, India.
Monteath, John, Rajkot, Kathiawar, Bombay, India.
Rosse, Right Hon. The Earl of, The Castle, Birr, Ireland.
Slade, Frank, F.Z.S., The Horniman Museum, Forest-hill, S.E.
Smith, Richard Tilden, Oaklands, Cavendish-road, Balham, S.W.
Townley, Charles Harry, 153, New Bond-street, W.
Right Hon. The Lord Mayor of London (Alderman Sir George Wyatt Truscott), Greatwood, Chislehurst, and 3, Suffolk-lane, E.C.

The following candidates were balloted for and duly elected members of the Society :—

Haigh, George, Norwood-mills, Southall, Middlesex.
Hardee, Oscar, Summerhill-lodge, Chislehurst.
Harrison, P. Walton, County Surveyor's Office, Norwich.
Hewett, Bertram H. M., A.M.I.C.E., M.Am. Soc. C.E., 564, West 33rd Street, New York City, U.S.A.
McCarthy, Edward Valentine, J.P., Ardmanagh-house, Glenbrook, Co. Cork, Ireland.
Osborn, N. F. B., 11, Bruce-grove, Tottenham, N.
Rosenfeld, Benedict, 8, Lindfield-gardens, Hampstead, N.W.
Stokes, Rear-Admiral Robert Henry Simpson, R.N., Junior United Service Club, Charles-street, St. James's, S.W.
Taylor, Charles Davenport, 11, Stafford-terrace, Plymouth, and Santa Ann, California, U.S.A.

The CHAIRMAN, in introducing Mr. McConnell, thought that although papers on a large variety of subjects had been read before the Society, not one had been read which was of more importance to the members of the community generally than that which was about to be delivered. In addition to his wide knowledge of dairy farming, the author was a well-known writer in the agricultural press, and he had published a text-book which was invaluable to farmers and agriculturists.

The paper read was—

LONDON MILK SUPPLY FROM A FARMER'S POINT OF VIEW.

By PRIMROSE McCONNELL, B.Sc., F.G.S.

The general development of the new milk trade within the last twenty years or so has been quite extraordinary, a state of matters brought about by several different causes.

The collapse of corn-growing made farmers look round and endeavour to find some other systems to take its place, with the result, in many districts, that cows to a large extent gradually supplanted wheat, whilst alongside of this the consumption of new milk by the public has been steadily increasing for years, the increase by some being estimated at 50 per cent. as compared with the consumption a generation ago.

During all these years dairy science has been testing, experimenting and trying everything in connection with the practical production and handling of the milk, and I hope to place before this meeting some of the conclusions those of us who are in the thick of the fight have come to as to what should be done and what should *not* be done to enable us to produce clean, healthy milk as a matter of business.

The unfortunate thing is, however, that a large number of scientific men have taken up the study of the bacteriology of milk from a purely theoretical standpoint, and have evolved many ideas on the subject which are not only impracticable but are quite unnecessary from a public health point of view, even if they could be carried out. The man who has not tasted milk since he was a baby, and who knows nothing of the practical handling of cows in a shed, is not qualified to tell a farmer how he is to milk or groom his animals, no matter how much microscopical work he may have done, or how efficient he may be at inoculating guinea pigs. If this fact were realised by some of our official masters there would be less friction between the parties concerned, because there would be fewer attempts to enforce ideas which are not a bit of good to the consumers, while causing no end of trouble and expense to the producers.

To get down to actual details, it will clear the air considerably if we take a look at the bacteriology of milk. Swithinbank and Newman, in their huge tome on the subject, enumerate some 125 species of microbes which infest milk. For some reason or another they leave out a good many varieties given in other text-books, so we may assume that there are at least 130 species or varieties which affect milk and its products. Out of this number only some five, however, are labelled "pathogenic," namely, those causing scarlet fever, diphtheria, typhoid fever, epidemic diarrhœa, and tuberculosis. The first three may be dismissed in a sentence: no one will argue that these are ordinarily met with in cowsheds or in milk, but must be introduced from the outside. Their presence will be quickly shown, and everyone will agree that the local authority should take immediate steps not only to deal with an outbreak of fever resulting from their presence, but to prevent their presence in a locality altogether. Of the remaining two I shall have something to say later on.

The people who get up a scare on the question of the tremendous number of microbes in a cubic centimetre of milk are not playing the game fairly, but are either wittingly or unwittingly doing a grave injustice to the milk trade, and giving much unnecessary trouble. It is not the number of microbes that matters,

but the species, and it has just been pointed out that out of 130 species only five could possibly be injurious to health, and the number of millions of the others in a glass of milk is of no importance, apart from the fact that some of them are actually necessary in the economy of the dairy.

Now the point I want to emphasise is this: seeing that all the other microbes are labelled "non-pathogenic," why is it necessary to raise such a scare, and to get powers to cause producers an everlasting amount of trouble and expense to carry out all sorts of ideas to prevent these microbes getting into the milk, when their presence does no harm, and when indeed the presence of some of them is absolutely necessary?

What some of these ideas are I can best illustrate by examples within my own knowledge. At a medical congress at Edinburgh a member advocated putting a mackintosh round a cow, with four holes in it for the teats to stick through, so that she could be milked without any microbes falling into the pail. A certain authority tried to enforce the perpetual washing down and disinfecting of every cow-stall; some are advocating the grooming of the animals and washing of the udders before every milking, even if this should have to be done at three o'clock in the morning as well as in the afternoon; the dunghill is to be removed a long distance from the shed and the dung is to be wheeled out three times a day, and also at three o'clock in the morning before milking; the drains or gutters must not be covered in at any part; the "fore-milk" of each teat must be milked out first before the bulk is drawn into the pail—on to the ground, I presume, where it will make a bigger mess and develop more microbes than if milked into the pail in the ordinary way: the colostrum (or first milk of a newly calved cow) must not be used till a week elapses, and so on.

I am quite seriously expecting to hear that some "authority" is demanding to have the teats disinfected internally with a syringe before milking begins, that the cow is to have her nails pared and her ears kept clean, and her teeth are to be cleaned daily with a tooth-brush, and all pieces of decaying food carefully picked out of them. These things are not an atom more impracticable and nonsensical than many of the propositions actually made by various authorities.

All these and many more things—some of which are impossible in practice—are recommended, and an attempt made to enforce them for the avowed purpose of keeping the bacteria out of the milk, notwithstanding the fact that when we come to study these bacteria we find that they are doing no harm. As an illustration, take the most common microbe in a cowshed, the *Bacillus coli communis*: this is the ordinary intestinal bacillus, and already exists in millions in the inside of every mammal. If several millions more get into the milk, it may be asked what harm they will do to the consumer. They will make the milk go sour prematurely; but that is not a danger to public health, for the milkman who supplies his customers with milk that will not keep is likely to lose their custom, and if these customers did drink the sour milk it would do them no harm, in proof of which it is only necessary to cite the fact that the rural population of the north of England, and all of Scotland and Ireland, drink sour milk by the thousand gallons, and thrive on it, while not so long ago medical men were recommending sour milk to their patients. When we recollect that all the vigorous northern races of Europe—as distinct from the effeminate southerners—drink sour milk swarming with all sorts of bacilli, we begin to wonder where all this bacterial lunacy is going to end.

A moment's reflection will show how much of the food of some of the most vigorous nations on the earth is composed of milk that is "tainted," from a bacteriologist's point of view. We have the Kephir and the Koumiss of the Caucasian and the Cossack; the "stringy" milk of the Dutch and Swedes; the sour buttermilk used over three-fourths of the British Islands; while every variety of cheese is swarming with many kinds of microbes, which must be present to provide its quality and flavour. Sour buttermilk and bread baked with colostrum, or "beistings," are regular items of food and drink in Scotland and Ireland, and I have eaten and drunk my fill of them many a time; and yet in the face of all this there are some who try to make out that the presence of a hundred harmless microbes in the milk is inimical to health, and move heaven and earth in an attempt to get legal powers to do the impossible—to prevent them from getting into milk.

Sterilization and Pasteurization are failures, and they are failures just because all the microbes in the milk are killed out. Milk ceases to be palatable, or a good digestible food, when deprived of the life action of its microbes, and the babies fed on it become stunted and ricketty, while those that get a

liberal supply—microbes and all—thrive on it. To my mind this result alone ought to prove that excessive and impossible sanitation is now not only not needed, but does actual harm to the consumers. Some one has compared the process of sterilization to shooting down a regiment of friends on the off chance that there might be one enemy among them, and the same analogy may be applied to the excessive sanitation of cowsheds.

I hope no one will be foolish enough to suggest that I am arguing in favour of producing dirty milk. I am as well aware as anyone of the fact that some cowsheds are not up to the mark and are capable of improvement; but I have not in recent years seen any so bad as those described in some of the reports of various officials, and I take leave to think that they have been either magnifying the evils or else they were not competent to make an inspection. I have probably seen more cowsheds than anybody else in the British Islands, for I have travelled many thousands of miles between the Alps and the Rocky Mountains, and have taken particular care to see the byres wherever I have been, for the construction of these has always been a hobby of mine.

I am persuaded, after much experience and many trials, that the cleanliness of a cow and the sanitation of the milk depend entirely on the special and particular arrangement of the parts of the cow's stall, and it is just on this very point that our officials are at fault, from ignorance. When they attempt to lay down rules as to the size of a shed, the style of a stall, the depth and width of the gutter behind, the arrangement of the manger in front, and so on, they are liable to make egregious blunders, and recommend a condition of things which would not conduce to cleanliness any more than the old methods, and to cover this they insist on excessive washing, grooming, disinfecting, and so on. When the stall is exactly adjusted to the size of the cow, and there is a wide and deep gutter behind, the animal stands and lies clean, and excessive labour in cleaning is not required.

There is an immense amount of misconception abroad on the question of the cubic air space required per head in a cowshed. Our authorities seem to think that air space and ventilation are the same thing, when they are nothing of the sort. If the ventilation is properly arranged for, then the mere air space in a shed is a very subordinate affair. As a matter of practical commonsense the amount of space allowed per cow should be regulated by the room required by the cow to stand in, and for the attendant to do the necessary labour connected with her. For this purpose 500 cubic feet per head is amply sufficient for a single-row byre, and less will do where there is a double row, with one central working gangway. Yet in the face of all this some of our local authorities, led by their sanitary officials, insist on 800 cubic feet per head. This means that the one cowshed costs twice as much to erect as the other, is far too cold in winter time to keep the cows comfortable, and does not improve the cows' health or the public health in the slightest degree. As to floor space, 50 square feet per cow in single and 40 square feet in double sheds is amply sufficient, yet some sanitarians insist on 80 feet. If these rules and regulations before adoption had been submitted to practical men they would have been considerably modified, and many thousands of pounds would not have been wasted by the unfortunate producers, and without detriment to the public health.

It was mentioned above that a proper system of ventilation is necessary, and that if this is satisfactorily carried out, then a very small cubic air space only is required. The best I have ever heard of was advocated by Mr. Christopher Middleton (Cleveland) at the recent conference of the British Dairy Farmers' Association. He cut a hole through the wall of his cow-shed between each two cows in the stall, and covered it with perforated zinc both outside and inside. The hole was at the level of the mangers, and he found that even in the coldest nights of winter the animals lay with their noses at the opening. I lately had occasion to remodel my own cowshed, and have been looking round for the best system of ventilation to adopt, and I am so satisfied with this that I am fitting it up myself. The fresh air is delivered at the very noses of the cows, where they want it most: the perforated zinc prevents a draught, and other ventilating openings, cubic air space, &c., are of subordinate importance.

We now come to consider the important question of tuberculosis and the milk supply. There has been a Royal Commission sitting for many years on the subject, and they have issued several interim reports, in which they have proved to their own satisfaction that bovine tuberculosis is communicable to man. Their exact words are:—

"There can be no doubt that in a certain number of cases the tuberculosis occurring in the human sub-

ject, especially in children, is the direct result of the introduction into the human body of the bacillus of bovine tuberculosis; and there can also be no doubt that in the majority at least of these cases the bacillus is introduced through cows' milk."

It may be pointed out straight away, that their far-fetched experiments and tests have not proved it to the satisfaction of many people who understand the matter just as well as they do. To begin with, Koch himself—the discoverer of the bacillus that causes the trouble—reiterated his belief, at the International Congress on Tuberculosis, that the bovine variety is not transmissible to human beings. Further evidence is plentifully to hand, but I confine myself to a quotation from Mr. Harold Leeny, a noted veterinary surgeon, on the matter:—

"So emphatic a statement, and from such a body of experts, commands the greatest respect and most careful consideration, and if one ventures to criticise the findings of the Commission it must be based on some of its own results, to which possibly sufficient importance has not been attached if looked at from the veterinary aspect, and we would here refer to the difficulty experienced in infecting calves when fed with virus. If repeated doses, and these large ones, failed to produce the disease: if calves suckled by cows in which tuberculosis of the udder had been intentionally produced showed the infection of but one out of six, and if all the fourteen calves "artificially" fed with tuberculous milk escaped entirely, how much risk is there, we wonder, from a stray bacillus in mixed "milks," whether given to calves or children? Of the tuberculous cows in dairies, how many have pronounced tubercle of the udder? Very few, we think. In any attempt to measure the risks of infection as between bovines we need to have more light on the natural means of infection, and this the experiments of the Commission do not afford. The difficulty of infecting calves by feeding with materials known to be infected with the specific bacilli is specially alluded to in the report, but the successful means employed are such as can never occur in the ordinary life of cattle, namely, inoculation under the skin, or injection of virus into the veins, in variable quantity. This danger of infection may be for all practical purposes ruled out, and, as we have seen, the liability of taking the bacillus in the food is small; while the probability of escaping any consequences is great, even when taken in doses intended to test the question thoroughly. It may be, then, that Dr. Koch was not so very far wrong, from an every-day practical point of view, when he said that the risk was comparatively slight of infection of human subjects by taking the milk of tuberculous cows, by which, of course, he did not specially indicate those with udders wantonly infected, but suffering in various degrees from generalised tuberculosis."

A fact is lost sight of with regard to tuberculosis which ought to be prominently brought forward, namely, that not a single case of actual transmission of the disease from the cow to the human being has ever yet been followed out and proved. The microbes of tubercle have been found in milk; some persons who have drunk that milk are known to be tuberculous, therefore they must have acquired the disease from the milk—a beautiful example of the old fallacy, *Post hoc, ergo propter hoc.* The strange thing is that the slum-dwellers and others who are worst affected with tuberculosis seldom use milk at all, while well-to-do people who are the greatest consumers of the product are comparatively immune.

It would be an instructive experiment if some of these scaremongers were to take two groups of dwellers in the slums, feed one with a fair supply of the ordinary commercial milk of the town, and let the other live in its ordinary way. The result in a short time would convince every fair-minded observer that milk, even if inferior and teeming with microbes, will make the consumers thrive, and that it is the want of milk that is the cause of much of the infantile mortality and general disease. It would be an object-lesson very easily and cheaply carried out, and would be very conclusive proof.

It is significant that while deaths from consumption have been reduced by 40 per cent. during the last generation the consumption of milk has probably doubled. On the face of it therefore we must look for the cause of the spread of consumption elsewhere than in the milk.

Assuming for the moment, however, that the human and bovine forms are identical and intercommunicable, the next point is, what are the possible chances of intercommunication? I think it is now generally acknowledged that there is only danger to be feared in the case of cows with tuberculous udders, and if these are removed from a herd then the danger becomes negligible. Now in my own experience, during which I have personally handled several thousands of cows, I can only recollect a few that I suspected of udder affection, say, 1 in 500. I notice that an official inspection by expert veterinarians of the cows in the London area, quite recently, resulted in a similar finding. Everyone will agree that the immediate removal of such animals is necessary, and, whether at public or private expense, the cost would be infinitesimal.

As bearing on this point, I may quote some evidence given in the *Journal of Hygiene* by Prof. Hewlett of King's College, on London milk. Samples of 26 counties were tested, and in only one was the tubercle bacillus found. This was followed out and traced to one cow, which was destroyed by the farmer; but the point is that, apart from the doubt there is of the identity of the two forms of tubercle, the actual chance of contamination is small.

Every one, again, will agree that all animals "clinically" affected with the disease—that is, all animals visibly diseased, all "piners," "wasters," &c.—must go to the knacker. My own experience is that, under present and recent sanitary conditions, not more than one in 200 animals per annum develops such symptoms, and that, apart from all questions relating to public health or official inspection, it would not pay a farmer to keep such cows a minute longer in his herd than he could help.

After these are got rid of, however, there remains the great body of the cow population of the country—say, 99 per cent.—some proportion of which has generalised tuberculosis, and it is these we have to deal with. Some of our authorities propose, in a light-hearted way, to enforce testing with tuberculin and then slaughtering off the reacting animals. But, to begin with, some one else has calculated that the compensation for this wholesale slaughtering would amount to £25,000,000, to be followed by an upsetting of all markets connected with cows and milk for years to come.

Before we do this, however—and this is the crux of the whole matter—it has yet to be proved that the tuberculin test is reliable, and secondly, that reacting animals are a danger to the public. This is not the time or the place to enter into a discussion on the use of tuberculin, and therefore I content myself by pointing out that the evidence against this test is accumulating. I was one of the first to try it in this country, and my experience warranted me in paying no heed to it since then, while I notice that Sir Walter Gilbey, in his recent book on "Milk and Milch Cows," gives some evidence that injecting tuberculin into a cow's neck is sufficient to start the disease in an animal in which it is in a suppressed or non-active state.

In the present state of our knowledge, therefore, and apart from what it would be desirable for a farmer to do to clear his herd of this disease, public health is perfectly guarded by the removal of animals visibly affected by the disease or with tuberculous udders, together with proper ventilation and stalling in the sheds.

There remains one more disease alleged to be carried by milk, namely, infantile diarrhœa, and in connection with this I shall confine myself to a quotation from the Medical Officer of Health for Westmoreland:—

During the four weeks ended Saturday, August 31st, 1907, only 150 deaths were attributed to diarrhœa in London, the corrected average being 1,330 for that period in previous years. How is this enormous decrease to be accounted for? The medical officers of county boroughs, metropolitan boroughs, and such large town centres advocate municipal milk depôts with a view to prevent mortality from this disease, caused, they say, by the dirty udders of the cows, the dirty hands of the milkers, and the foul water with which the milk-churns are washed in the country whence the milk comes. What has happened during the last four weeks to the Londoner's milk? Have the udders of the country cows and the hands of the country milkers all suddenly become clean, and has the dirty water which formerly washed the country churns suddenly become pure, or is there not some other cause which has brought about this enormous improvement in the public health? Remembering that the children of the merchant, the professional, and the aristocratic classes drink large quantities of milk but seldom or never die of diarrhœa, but that it is the children of the artisan class that die of the disease and consume very little milk indeed, is it not perfectly just to assume that the country milk that goes to London is pure when it leaves the parish in which it is produced, and in which the same milk, there consumed in large quantities by the farmers' children, is associated with an infant mortality rate of 50 to 70 per 1,000 per annum, not 150 to 280 per 1,000, as in some town districts?

The summary of the above deliverance is that the children who drink the milk in London do not become affected with diarrhœa, while the children who do not get any milk take the trouble very badly. Assuming, therefore, that Dr. Klein is right, that the *Bacillus enteriditis sporogenes* is the cause of epidemic diarrhœa, and that it is found in milk, it has to be explained away how it is that children who drink the most milk have the lowest rate of infection, and, conversely, how the babies who never taste milk die of this disease like flies. Until this is explained the opinions held to the contrary can only be treated with contempt.

Before leaving the question of public health, another point in connection with the production of milk should not be lost sight of, in view of the ideas promulgated about the unhealthiness of the surroundings where it is

produced, and that is the healthiness of the cowmen who practically live a large part of their lives in the cowsheds with the cows. If the animals are tuberculous, and the dust of the sheds is teeming with microbes endowed with deleterious powers of all sorts, with a resultant danger to the public health, how is it that the workmen, exposed a hundred times more to this influence than any member of the consuming public, remain healthy? I have been personally handling cows now for at least forty years, yet I cannot recollect ever having known an unhealthy cowman or dairymaid, or a case of disease acquired in a cowshed. Most of those known to me were consumers of milk, and I have been a large drinker of raw milk myself—both in the sweet and in the sour state—all my life.

We now come, lastly, to the question of a standard or limit in the analysis of milk. Some years ago, the Board of Agriculture, after inquiry by a Departmental Commission, fixed a limit of 3 per cent. of fat, and 8·5 per cent. of other solids, and any sample which fell below these, on analysis, was to be reckoned not of the nature and substance of milk, until the contrary was proved. This means in practice that if, on analysis, a sample does not come up to this standard, then the chemist affirms that the producer has added such and such a percentage of water to it, or has removed a certain quantity of cream. Now be it noted that no farmer, known to me, has any objection to this standard, or any wish to have it lowered, but everyone does object very decidedly to the way that it is administered. The practical experience of cowkeepers is, that there are times and conditions when the mixed milk of a whole herd falls below this standard, and no method of treatment or management can prevent or cure this condition of things. There are two seasons in the year when this is likely to happen—in the spring, when there is a flush of lush grass, causing a flowing yield of milk from the cows, and in a hot, dry autumn, when there is no grass at all, and the cows are thirsty and drink a lot of water. In addition to these there are days when the milk constituents come low, from causes unknown to us, and which we cannot possibly prevent. In my own tests I have had the morning sample show 3·4 per cent. of fat, next morning it fell to 2·5 per cent., and the third morning it was up again to over 3 per cent. I had done nothing to cause such a variation, and as the reason was and is unknown, I could do nothing to prevent it; but the point is, that if an inspector had taken a sample on the morning of the poor quality I would have been summoned and fined for "watering" my milk, although it was the natural product of a mixed herd of cows. Now the grievance is that though the Board of Agriculture has issued regulations concurrent with the rules regarding the "standard" which meet such a case, yet magistrates, police inspectors, and chemists persistently ignore them. Contrary to the usual custom of British courts of law, the accused is considered guilty and has to prove his innocence: the regulations on this point permit of the accused offering a defence and proving his innocence, but in many cases this is not permitted. I know of instances where the magistrate has refused to hear the evidence of witnesses and experts for the defence, and one medical officer of health has put in print his opinion that the Board of Agriculture had no business to make conditions for administering its own regulations. There would be no trouble if these regulations were administered properly by those in authority, and if they could be got to understand that honest milk occasionally falls below the "standard," and allow evidence to be tendered to that effect.

I must now conclude though I have not touched on one-half of the points that require discussion, but this paper is already long enough.

All these troubles would for the most part right themselves if the "authorities" really understood the matter. We expect that a veterinary surgeon shall have a practical acquaintance with live stock, that a surgeon shall have been trained in a hospital for the performance of operations, and we are entitled to ask that the official who lays down the law regarding the ordering of a cowshed, or comes to inspect it, should know something about cow-keeping. To quote from a statement of my own made elsewhere: "Everyone who sets himself up as an authority on the methods of milk production should have served for, say, a winter in a byre, where new milk for sale is produced. Let him try his hand at washing udders at 4.30 a.m. on a frosty morning, and afterwards milk with a dry hand. Let him take his turn at wheeling out the dung 'to a considerable distance,' as one authority phrases it, and do all the other things that some want us to do. If he finds he can do these things himself in the way he wants the ordinary dairy farmer to do them, then I am willing to submit. *Per contra*, I am of opinion that the man

who has been through this as part of his training, will not want so many absurd things done as some are now trying to enforce."

We are promised a Bill before Parliament soon which will embody the united wisdom of all the sanitarians who think they know how milk should be produced, and which will take the place of the piecemeal legislation to which we have hitherto been subjected. I sincerely hope—though I doubt it very much—that the man who will be most affected, the man who makes the milk, will have a chance of revising the Bill before it becomes law.

DISCUSSION.

Dr. J. A. VOELCKER, in opening the discussion, thought there was a tendency amongst scientific men on the chemical side to pay more attention to the microbes that existed in milk and other products than they deserved. The author was absolutely right in stating that a mistake had been made by scientific people in leading the public to believe that a microbe was a harmful thing, because it need not be anything of the sort. It was not the number of microbes but their nature that made all the difference. He did not hesitate to say that the suggestions put forward in a report which had recently been issued throughout the north of England, especially in Yorkshire, with regard to cow-sheds, were not merely impracticable, but the attempt to carry them out would be putting a toll on the farmer which no one had a right to impose on him, while no improvement whatever would be made in the health of the public through their adoption. Mr. McConnell had rendered a public service in calling attention to the fact that there was no reasonable belief for the fears that had been put forward, and he had rendered a service to the agricultural community in putting their case fairly before the public. He thought the author was quite right, too, in his assertion that those who made regulations with regard to the amount of air space necessary in cow-sheds knew nothing of the facts of the case. A small space might be perfectly healthy, while a big space might be exactly the opposite. A farmer was perfectly justified in saying that he should have a reasonable and practical individual to deal with him in his business. But while he made those remarks, he did not wish it to be supposed for a moment that he contended that the position of the farmer was unassailable. He went so far as to say that he thought it was a very good thing in some ways that agitations had been raised, because the farmer would not have done as much as he had unless he had been compelled. The matter was one of compromise. The people of London were now very particular about the cleanliness of their milk, but he did not know that they were very particular about the state of the streets in which they walked. It was not fair to say that the farmer deliberately allowed pieces of straw, for instance, to get into the milk and that he did not take every precaution to keep them out. It would be very easy to alarm people a good deal more about things which went on in everyday life, and which they passed over without any thought. He thought the author had done a service in referring to the virtues of fresh milk, and it would take a long time to persuade him that some of the vital properties of the milk were not destroyed by its sterilisation or Pasteurisation. From his personal experience, he must say he did not believe in the tuberculin test. He strongly held when a farmer had a cow which was manifestly suffering from tubercular disease of the udder, it was his duty to destroy it, and he thought a mistake was made in claiming compensation for its destruction, although, if the disease was only discoverable by a veterinarian making a certain test, over which the farmer had no control, a fair case might be made out for compensation. With regard to the standard of milk, every one would recognise that if it was set too low, there would be farmers who would take good care that it was not exceeded. There was greater safety in putting the standard fairly high, and experience showed that in a well-kept herd, there was little difficulty in keeping up to the standard.

Mr. A. L. ALEXANDER thought the most important point in the paper was the acknowledged fact that the children of the rich, who had all the milk they required, were immune from a great many of the diseases from which the children of the poor, who drank very little milk indeed, suffered.

Mr. LEON GASTER inquired whether, in the author's opinion, milk should be boiled before it was used. He also thought that the people of the country required teaching that it was necessary to keep the milk clean after it was received from the farmer, because in many cases it got dirty in the houses before it was used. He was also of opinion that ventilation was more essential in a cow-shed than the cubicity of the air space. It was a well-known fact that if the amount of carbonic acid (CO_2) in rooms increased beyond 7 or 10 parts in 10,000 it had a detrimental effect upon those living in the rooms, and the same principle applied to the air breathed by cows and dairymen in the sheds.

Mr. FREDERICK J. LLOYD said he had hoped that some of the members of the medical profession, who must have seen the notice of the paper, would have been present to justify the attitude they had taken up on the question under discussion. It was a most extraordinary fact that whenever the subject was discussed in public medical men were conspicuous by their absence. In dealing with the question as to whether it was desirable to drink fresh milk or boiled milk, at one time a great number of doctors said it was desirable that the milk should

be boiled, but the best authorities in the world were now coming to the conclusion that that was not the case, and that it should be drunk in its natural condition. It had been shown, especially by French medical men, that the boiling of milk, instead of doing good, did harm. Personally he had known so-called sterilised milk which had been kept for a long period to be absolutely poisonous; while Pasteurised milk was so changed in its chemical composition as to destroy some of the most valuable properties of milk as a food, especially for children. The great authorities of the Pasteur Institute had come to the conclusion that the organism which was natural to milk, and which produced its souring, was one of the most beneficial in the world, that it considerably assisted digestion, and acted as a sort of policeman in preventing organisms which were injurious from having the effect they otherwise would. He was sorry Dr. Voelcker had spoken against tuberculin, because, speaking from the scientific point of view, he (Professor Lloyd), believed it was one of the most valuable discoveries that had ever been made, and he suggested long ago that it should not be sold unless it had a Government stamp to ensure it was absolutely free from living organisms. It was perfectly impossible for tuberculin, which did not contain a single tubercle bacillus, to produce the disease; if it did it had not been properly prepared. Bacteriologists found fault with him because, in examining samples of milk to determine whether the tubercle bacillus was present, he treated a certain quantity of the milk in a separator and examined the sediment. He was told that he would not be able to detect the tubercle bacillus in that way, because it was not present in sufficient numbers to ensure their being found in the sediment. But it was possible to find in the minutest trace of sputum which came from an individual suffering from consumption an enormous number of tubercle bacilli. Which, therefore, was likely to be the more dangerous, the milk in which it was said that, if the bacteria were present, there were so few of them that they could not be determined, or sputum which contained such enormous numbers? Tuberculosis was being disseminated by the dust and dirt from the ground-up, dried sputum which was spread about our towns and buildings with impunity, which people inhaled without knowing it, and which, if it was deposited in a human being in whom the organisms could live, would produce the disease. It was the want of cleanliness in the atmosphere which was the cause of infantile diarrhoea. It had been shown by the great bacteriologist, Dr. George Newman, that of the children dying from infantile diarrhoea in Finsbury, over 50 per cent. were fed upon condensed milk, which did not contain bacteria. The disease was produced by organisms which entered into the milk, whether it be condensed or fresh, from the dirty atmosphere in the homes of the poor. The Government had laid down, not a standard for milk, but certain limits, and if the milk fell below those limits the assumption was that the milk had been adulterated, which was a very fair position to take up. But what was unfair was the way in which the inspectors prosecuted a farmer on a single sample, without taking the trouble to ascertain whether the milk would fall below those limits continuously. The inspectors, who took the samples, had a remarkable knowledge of when they were likely to get milk which fell below the limit; and if the case was taken before the Magistrate, he would not listen to the evidence of an expert. He would not object if the inspector charged the farmer with delivering milk below the limit, but the farmer was often accused of having wilfully adulterated the milk when there was not an atom of evidence in support of such a statement. He firmly believed with Koch that the tubercle bacillus which was characteristic of man was not the same as the bacillus which was present in bovines, and that more harm than good would be done if an enormous sum of money was spent in eradicating the disease from herds, causing the public to think that the spread of consumption would be stopped. It might benefit the farmers to get rid of the disease, but it would not benefit the public if, in the meantime, the atmosphere which they breathed was contaminated with bacilli from human beings.

Dr. R. DUDFIELD (Medical Officer of Health, Paddington) said he felt compelled to rise because of the reflections which had been passed on his profession by the last speaker. He came to the meeting, expecting to hear a practical paper from the farmer's point of view, but he had not learned anything of the difficulties which farmers experienced in carrying out the proper method of producing milk. The bacteriological test was not made so much for the purpose of distinguishing the 150 or 200 varieties of bacteria which were present in milk, as for determining the amount of dirt which had got into it since it had been taken from the cow. Dr. Voelcker had intimated that a little clean straw in the milk, did no harm, but what would happen if the straw was manure sodden? The author seemed to indicate in his paper, that he did not mind taking the bacillus coli, which came from the fæces of the cow, into his system. It was not a pleasant thing to imagine that the milk which was being supplied was contaminated with cows' excrement. Professor Lloyd had referred to the question of the identity of bovine and human tuberculosis. At the last congress on tuberculosis held in Washington, which was attended by some thousands of medical men from all parts of the world, only one man took up the attitude that the tuberculosis bacillus discovered in bovines was not identical with that found in human beings, and that man was Professor Koch. He did not know why the farmer should rely on one man against the whole of the profession. People on the continent were following out the rules which had been laid down by the experts who had been so freely criticised, and as

a result their dairy products were displacing those of this country.

Mr. E. G. EASTON, L.C.C., thought that, whether Dr. Dudfield's views were right or wrong, every one present welcomed him to the meeting and wished that more London medical officers were present. When Dr. Dudfield referred to the Congress at Washington, and asked them to believe the opinion of the 999 as against the one, he was reminded of Galileo, who expressed an opinion against unanimous opposition, but who proved to be right, and they had yet to learn that Dr. Koch was wrong. Personally he was persuaded the more the question was enquired into that Dr. Koch must be right. With regard to the question of the tuberculin test, it was his private opinion that if animals which were slightly predisposed to tuberculosis were injected with tuberculin they developed the disease. The tuberculosis clauses in the County Council Bill which enabled the Council's inspectors to go all over the country, were absolutely inoperative, because they simply had the effect of shifting the cause of the tuberculosis from one district to another. As soon as the inspector found a cow suffering from tuberculosis, and informed the farmer of that fact, the cow was immediately "missing." He disagreed with Professor Lloyd's view that cow-keepers should not be compensated for animals that were slaughtered, because in most cases of tuberculosis it was not until the cow was killed that it was known whether the animal was suffering from the disease. With regard to the question of infant mortality, at one time the statement was made that where there were municipal milk shops and the advice of medical officers was taken, the disease decreased, but reference to the Registrar-General's returns conclusively proved that the districts in which there were municipal milkshops had a larger rate of infantile mortality than those that did not possess them. He was sure that Mr. John Burns would glean a great deal of information from the paper. He trusted an opportunity would be given to practical men who had spent their lives in the production and distribution of the milk to consider the Bill, and he believed that the country would gradually learn that they had been woefully led astray by a number of gentlemen whose hearts were right, but whose knowledge was sadly deficient.

Mr. ALEXANDER STEEL was perfectly certain that it was not the drinking of milk which produced disease, but the fact that so little of it was drunk. Many families which could afford to spend a considerable amount of money on milk did not buy more than was necessary to use in their tea or coffee, night and morning. Dr. George Newman, of Finsbury, had stated that the consumption of milk by the working people of Finsbury only amounted to one-tenth of a pint per head per day, and by well-to-do people to one-fifth of a pint per head per day, and that in that borough nearly 500 people out of every thousand never touched fresh wholesome milk at all. If people would only drink milk there would be less diarrhœa and consumption, and the community would be much healthier. He entirely agreed with the author that 800 feet of air space per cow was not necessary in a cow-shed, but that the ventilation was the important point to which attention should be paid. He made every effort to produce his milk in as cleanly a fashion as possible. He did not allow his men to go into the cow-shed without washing their hands, and without carrying a little pail of clean water in which to wash their hands after milking; and he also made them take a swab and clean the udders with it before commencing to milk. He thoroughly agreed with the suggestion that by-laws should be passed that more frequent inspections should be made by medical officers, but those gentlemen should be practical men who understood country life and the production of milk. Farmers did not attempt to compete with Danish farmers in the production of butter, simply because they could make more money by the sale of the milk. It took 2s. worth of milk to make a pound of butter, for which only 1s. could be obtained, and that explained the fact that British farmers were not such fools as to make butter when they could sell their milk at a bigger price.

Mr. A. H. H. MATTHEWS thought that if the assumption was made that pure milk was a wholesome food, it would be granted that it was desirable the public should get as much of it as possible. At present prices, the margin of profit was so small that the producer had to look carefully at ways and means, and if he were compelled to comply with the fads of medical officers and others who knew nothing about the practical side of the question, the cost of production would be so increased that milk as an article of food would be quite prohibited to all the poorer classes, a fact Mr. John Burns fully recognised in a statement he made to a deputation that waited on him in the early part of this year. He disagreed in part with Mr. Lloyd's remarks with regard to tuberculin, and thought it ought not to be sold at all. Tuberculin had been allowed to get into the hands of unqualified and unscrupulous people, and had been used to prevent diseased cows from re-acting. If it was used at all, it should only be used by officials holding a very high position, who were above suspicion.

The CHAIRMAN (Sir George Barham, J.P.), in proposing a hearty vote of thanks to the author for his valuable paper, said he was particularly glad that Dr. Dudfield had spoken, as it was desirable that both sides of the subject should be ventilated; and nothing would have given the dairy farmers greater pleasure than that the medical officers should be far more fully represented at the meeting than they had been. He was of opinion that if tuberculosis was to be got rid of the owners of the cows which were con-

demned should be compensated, for the simple reason that unless that course were adopted the small owners would not inform the authorities of cases of disease. On the other hand, if they were paid a reasonable amount of compensation they would be the first to give notice, and the disease would in that way be eradicated. He was afraid it was impossible to restrict the use of tuberculin to those in authority, as it was manufactured abroad, and those who wished to use it on their cattle so that they would not re-act when tested a second time could easily obtain it. He thought people had lost sight of the fact that dairy farmers and dairymen in this country were doing everything they possibly could at the present moment to deliver a supply of absolutely pure milk. Great efforts had been made in the last 20 years to improve the dairy industry, with the result that British farms would compare favourably with those of any other country. They possessed some of the best cattle in the world; the pastures in many places could not be equalled; and the train service for milk was equal to, or better than, that in France, Norway, Sweden, and other countries. Milk produced at six or seven o'clock in the evening was on the consumer's breakfast table as early as five or six o'clock the next morning, and the morning milk was delivered by one o'clock in the afternoon. In France the milk was sent to the large towns only once in 24 hours, so that the large towns in this country received fresh milk 12 hours earlier than towns on the Continent. When Mr. Burns received a deputation with regard to his Bill, he said that he had visited dairy shows in the United States, Canada, and other countries, but he had seen nothing equal to the Dairy Show in London, this year. There could be no doubt that the dairy industry had advanced more in the last twenty years than any other branch of agriculture, or any other industry. Dairy farmers had an open mind on the subject, and were only too pleased to avail themselves of useful practical hints for the better production of milk, and its distribution.

The resolution of thanks was then put, and carried.

Mr. McConnell, in reply, said he was a little disappointed that his paper had not received more adverse criticism. Dr. Voelcker had referred to the question of compensation being paid for cows that were destroyed because they had tuberculous udders, or were clinically affected. He was not inclined to press for the payment of compensation, because, as only one cow in 500 had a tuberculous udder, the matter was not a serious one; and with regard to the others, if they were kept too long, they would have to go to the knacker anyhow and he did not pay anything at all unless he could help it. Boiling milk was equivalent to either sterilisation or Pasteurisation, and it was not a success. Personally he would rather take the risk of consuming microbes than drink boiled milk, the taste of which was abominable. It was a very good plan to test the ventilation of a cow-shed by the carbonic acid test. From his long experience he could tell by his own nose whether a cow-shed was getting "stuffy," which meant there was an excess of carbonic acid present; if it smelt sweet he was satisfied that the temperature and the ventilation were correct. He was struck with the fact pointed out by Mr. Lloyd that medical men were rarely present at such discussions. It almost looked as if they liked firing shots from behind a hedge and then running away. With regard to the effect of the injection of tuberculin, an ordinary healthy cow might have suppressed tuberculosis, which did not show itself in its ordinary short life, so that for all practical purposes the cow was perfectly healthy, but tuberculosis appeared immediately after tuberculin was injected into the neck. Dr. Dudfield had stated the paper was not what he expected, and that he had not learned anything new from it. If that was his position he was a very remarkable medical man, because, judging from what other men had said, they were not acquainted with the points referred to in the paper about cubic air space, the construction of cow-sheds and the shape of a stall. He did not know what else he could have said from a farmer's point of view, because although bacteriology was not a common subject for farmers to study, they were not all so ignorant down in the country as some people assumed. He challenged the remark Dr. Dudfield had made, that it was the dirt in the milk which did the harm. It was the microbes that were along with the dirt which caused the mischief. Ordinary microbes did no harm, and the solid part of the milk was simply inert mineral matter which was harmless. The little dirt which got into the milk could not do any harm, provided there were none of the bad microbes present. Then Dr. Dudfield inquired why dairy farmers preferred to take Dr. Koch's opinion against the opinion of the thousands of doctors who assembled at the Washington Congress. The fact of the matter was that Koch discovered the microbe that caused tuberculosis, and knew more about it than all the other doctors put together. It was a pity the old story should be again repeated, that the dairy products of this country were being replaced by Continental goods. Farmers were not such fools as to use 2s. worth of milk to make 1s. worth of butter. They adopted the branch of dairying which paid them best, and were pleased to let the continental people send to this country as much butter as they liked, because English farmers had a better paying industry than the making of butter or cheese. He hoped that instead of the everlasting piecemeal legislation which had been the feature of the past, some sensible legislation would be enacted in the future. One uniform law was required for the whole country, but before it was passed it should be thoroughly thrashed out by the practical producers of milk as well as by those who were only acquainted with the bacteriology of the subject.

THE MINERALS OF INDIA.

Some valuable information is contained in a "Sketch of the Mineral Resources of India," by Dr. T. H. Holland, F.R.S., Director of the Geological Survey of India. During the past five years there has been a marked increase in the output of Indian minerals: *e.g.*, the total value of coal raised has grown from £1,366,909 in 1902 to £1,912,042 in 1906, and of gold from £1,975,336 to £2,230,284 in the same years, while in most other minerals a similar increase has been recorded.

COAL.

Perhaps the most interesting feature of the Report is the section on coal, which is becoming a more and more important product of India. "Coal," says Dr. Holland, "is to the country, as a whole, the most valuable mineral product being worked; its total value, as estimated by the low price which is accepted for it in sales at the pit-mouth, comes next to that of gold; it is by far the largest supporter of labour, and from 90 to 95 per cent. of the material raised is consumed in developing the domestic industries of the country. During the past twenty years, the production of Indian coal has risen from 1½ million tons in 1887, to 9¾ millions in 1906, while the partial returns, already obtained, for the year 1907, show a further increase in production of over one million tons. During the past year, there has been a larger demand than in any previous year, and prices are now at the highest level hitherto recorded, while the demand by the rapidly developing industries of the country is so great, that coal is now being imported from Natal, Australia, and Japan, as well as from Great Britain.

"Of the total quantity of coal produced in India, the railways alone consume nearly 30 per cent., but there has been a gradual tendency for the railways to take a smaller proportion of the output, thus showing that other coal-consuming industries have increased at a greater rate even than the railway expansion of the country.

"Indian coal has now almost completely displaced imported fuel on the railways; while in 1887 only 70 per cent. of the coal consumed was of domestic origin, during the past six years, over 99 per cent. of the coal, consumed on the railways, has been obtained from Indian mines.

"The coal workings in India are still very shallow, only one shaft having been sunk to a greater depth than 800 feet. The strong roof, due partly to the remarkable freedom of the country from tectonic disturbances for many geological ages, the light overburden of the shallow mines, and the general freedom from gas, have combined to reduce the number of accidents at the mines. The death-rate from accidents in Indian coal mines averages about 0·75—0·80 per thousand workers employed, against about 1·50 for the rest of the British Empire, and over 3 per 1,000 for the coal mines of the United States.

"The largest number of the labourers in the coal mines belong to the *kamia* class of landless day labourers, though some are agriculturists holding lands at a distance from the coalfields, necessitating periodical migrations to attend to their own crops. In some of the long-established mining centres a population is being evolved wholly devoted to mining which they now regard as their caste occupation. To this class allotments of land are sometimes made on a system which adds to the contentment of the miner and the consequent stability of the industrial system.

"A considerable proportion of the colliers are aboriginal Santals, Mundas, Oraons, Kols, and Gonds, the rest being semi-Hinduized low-castes, among whom communities of Bauris, who are normally palki-bearers and cultivators, have been cutting coal for so many generations that they now regard it as the special function of their caste. Large numbers of so-called *pardesi* labourers are brought from the United Provinces for work in Bengal, the Central Provinces, and at Singareni. The labour in the Assam coal mines is imported under the regulations governing the cooly emigration to the tea-gardens in the same province."

OTHER MINERALS.

Baluchistan is a country which is, as yet, only partially exploited, but the chromite industry continues to develop, the output for 1906 being 4,375 tons, as against 2,708 tons in 1905. This was, accompanied by a market rise in price, from 25s. to 32s. a ton. The diamond mines of India, once so famous, are now represented by mines in Central India, which produced in 1907 only £2,784's worth. It is stated that diamonds have been found in the Anantapur district of the Madras Presidency, but no statistics are as yet available. The gold yielded in 1907 was valued at £2,133,691, but this is exclusive of 13,383 ounces, valued at £50,216, which were produced at Hyderabad. In the Dharwar gold area, in Holland's opinion, operations have got beyond the prospecting stage, as the outturn of the precious metal was valued at £18,634. Graphite is worked systematically in the Travancore State only, and the production was considerably less in 1907 than the previous year. Iron ore decreased in quantity, but owing to richer deposits tapped in Singbhum, the value rose above that of the previous year.

Jadeite is a product confined (so far as the Indian Empire is concerned) to Upper Burma, where it is exported to China, either overland or by sea from Rangoon. The total out-turn was valued in 1907 at £49,643. Manganese was produced in far larger quantities than in 1906, and thus overtook the demand, large stocks of the ore accumulating in consequence at the mines. Similarly, there was diminished export of mica, but the value per ton rose from £4·78 to to £5·80.

The production of petroleum attained the record figure of 140 million gallons, nearly all of which came

from Burma, but notwithstanding this large output, imports of the same, from all foreign countries, amounted to 62 millions.

The rubies found in 1907 were valued at £93,023, while the sapphire mines in Kashmir are being extended, and several fine stones of value were obtained during the year. One was valued at £6,000 in the uncut condition. The tin ore industry in Burma continues to make slow progress, but the present methods of working the ore are capable of considerable improvement.

ARTS AND CRAFTS.

The Christmas Exhibitions.—There are always more little exhibitions of Arts and Crafts just before Christmas than at any other time of the year. Artist craftsmen apparently, look upon this season as an excellent opportunity of showing their smaller productions. And this idea affects the character of the exhibitions considerably. One cannot help feeling that, at the present time, exhibitors are, if not holding back their most important work, at any rate putting it more or less in the background and bringing forward smaller and less conspicuous objects, in the hope of disposing of them as "Christmas presents," and with an eye to the amount the average man or woman will be likely to spend on such things. Thus it comes about that, out of a multitude of little shows there is very often less to chronicle towards the end of December than at seasons when, apparently, far less craft work is on view. It is quite certain by now that the idea of showing some art handiwork at exhibitions consisting mainly of pictures has taken root. The New Gallery and various other galleries have been showing needlework, pottery, jewellery, or whatever it may be at the same time as pictures. Theoretically, this plan seems to be a very feasible one, although in practice people seem to look upon that part of the show as a rather negligible quantity. Of bazaar-like exhibitions combining some more or less philanthropic object with arts and crafts, handicrafts, home arts, or peasant industries, there seems to have been a larger crop even than usual. The trouble is that in such exhibitions the art is too often confined to the name.

M. Taxile Doat's Pottery. — Quite the most interesting little collection at present on view is the case of M. Taxile Doat's pottery at the New Dudley Gallery. M. Doat, who is attached to the manufactory at Sèvres, is a contemporary of M. Solon, and works in some respects on the same lines. But, whilst M. Solon, living on this side of the channel, has kept quite rigidly to *pâte sur pâte*, and devoted the better part of his life to perfecting his work in just that one particular direction, M. Doat, whose *pâte sur pâte* may be somewhat less marvellous, has gone much further afield, and has tried experiments of different kinds in branches of the ceramic art very far removed from that particular form of decoration, though the results of many of his experiments are very often to be found on the same piece as his *pâte sur pâte*. It is, for instance, a favourite practice of his to enrich a plaque, the ground of which is decorated with some fruit-skin or crystalline glaze, with a central cameo-like medallion. When, as is sometimes the case, a pot is in the form of a natural gourd or melon, whilst the ornamentation consists of little cameos arranged in the style of Louis XVI., it is open to question whether the combination is altogether happy, but that is a matter of taste, and one on which a Frenchman and an Englishman would be likely to think very differently. The association of *pâte sur pâte* and sgraffito is at times very happy. There is a vase in the New Dudley Gallery where a band of sgraffito ornament is broken very satisfactorily at intervals by dainty little medals in low relief. On the whole it must be admitted that the more reticent use of *pâte sur pâte* is the most successful, and there is many an unpretending piece of work by M. Doat which gives more real pleasure than the huge pot in the British Museum which, master-piece of technique as it most undoubtedly is, is none the less lacking in some of the charm which belongs to much of his smaller work. In fact, beautiful as the *pâte sur pâte* is, and interesting as it is to see specimens of this kind of work executed in colours—or, to be more strictly accurate, in white and colours—one cannot help feeling that in M. Doat's hands it is altogether more pleasing when it is used for medallion heads and similar purposes than when it is employed for more elaborate compositions. The vases to be seen in Piccadilly, however, are by no means all decorated with *pâte sur pâte*. M. Doat shows the results of experiments in many very different directions. Like so many other potters, he has been trying after crystalline effects—but the results he gets are quite distinctly his own, and some of his effects are as beautiful as they are interesting. There is one vase in which a pale greyish ground practically unbroken at the neck, is quite thickly spattered towards its base with crystals of various colours from light greenish turquoise blue to deep *sang-de-boeuf*. Another achievement well worth notice is the very unusual combination of lustre with crystalline effects which occurs on some of the pots. M. Doat's work as at present arranged is much better seen than it was at the Franco-British Exhibition, and it certainly repays the closer attention that one is able to give it. It is interesting to notice how, even when he is working on lines approximating more closely than his wont to English methods, the results are always quite unlike what an Englishman would do. There is no finer pottery being turned out anywhere than in England at the present day, but the production on a small scale over here is, in too many cases, not remarkable for the excellence of its technique, and it is good to see the work of an artist potter who is a master of his craft.

Christmas-cards and Post-cards.—In few things has fashion brought greater changes in recent years than in Christmas-cards and post-cards. The difference between the cards of to-day and those of some few years ago is not only, if mainly, due to the technical improvements in the three-colour process, or, indeed, to advances in any kind of process, but to a change in the public demand, and in what the youthful artist employed by the card makers is at the present day able and willing to supply. Of course, in the way of coloured picture post-cards, now so extensively used at Christmas time, the three-colour process has worked wonders, and new developments in colour printing are of almost daily occurrence. One of the happiest recent ideas, perhaps, belongs to Mr. T. R. Way, who is responsible for a series of London views printed in colours on fairly rough brown paper, not by the three-colour process but by lithography, in which Mr. Way is an adept. The familiar scenes lose nothing to those who know their London by being rather hazy in effect, and they gain a good deal by not being too sharply and clearly defined. The charm of London, after all, is far greater on a rather misty day than in the clear light of the midsummer sun.

While the best of the coloured post-cards are entirely devoted to pictures, Christmas cards proper seem to run more and more in the direction of ornamental lettering. It is really quite astonishing in turning over books of types for "private greeting cards" to find how seldom one comes across a picture—whilst the ordinary cards to be bought straight off at the shops follow much the same direction. It cannot be said that all, or even most, of the Christmas cards are very beautiful. There is a good deal of purposeless ornamentation about them very often—and sometimes there seems really no coherence in their design. But for all that there are hopeful signs. It is a great deal easier to buy passably good cards than it was some years ago. And this fact is directly traceable to the revival of the teaching of lettering in the schools. There is still bad lettering about, of course—poor imitations of Gothic characters as well as backboneless and sprawling modern letters, but there is also some good sober work as well as a good deal of quite creditable "script." Amongst others there is a series of "autograph cards" which started last year and has been considerably extended this season, in which script or rather severe lettering associated with an adequate but unpretending border, produces a card so satisfactory in its simple way that no one need be ashamed of sending it out. The revival of illumination has produced much more unequal results—and there are a good many cards to be seen in which this kind of decoration has fairly run wild, whilst others are not only well illuminated, but tasteful and restrained in arrangement. That a good many of these latter keep very close to old originals is perhaps not to be wondered at in view of the nature of the ornamentation, which naturally takes us back to the days of elaborately written and decorated books.

Oddly enough, the picture Christmas cards are not, on the whole, any better than they were some years ago—probably because the best efforts of the designers have been expended in the other direction. The most successful and most dainty children's cards, too, are those where the treatment is flat and rather decorative. The modern cards for children are modelled rather on the prevailing type of toy-book, than on the coloured illustrations, which have begun within the last few years to add to the joy of story books. This is quite as it should be, but it is none the less rather astonishing.

OBITUARY.

Captain H. R. Porter.—Captain Henry Richard Porter, who died at Leamington on December 13th, aged 77, was gazetted to the Royal Artillery in 1850. He took part in the China war of 1858-60 and was present at the assault and capture of Namtow, Shektsing, and the Taku forts, as well as the occupation of Peking. For his services on this occasion he was mentioned in despatches, was promoted to the rank of captain November 17th, 1857, and received the medal with two clasps. He became a member of the Society of Arts in 1883.

MEETINGS OF THE SOCIETY.

Juvenile Lectures.

Charles Waldstein, Litt.D., Ph.D., Slade Professor of Fine Art in the University of Cambridge, "Digging for Ancient Art Treasures." Two Lectures.

Lecture I.—January 6.—The excitement of the treasure-hunter—Uncertainty and mystery—Excavating combines all the elements of sport and excitement with higher and nobler spiritual aims—How ancient sites came to be buried—What the excavator might find in London two thousand years hence—Methods of excavating—Examples of prehistoric and Egyptian digging—The only records of prehistoric man out of which our knowledge concerning him is derived—Excavations of ancient Troy, Mycenae, Tiryns—Dr. Evans's work in Crete—Minos and the Cretan Labyrinth.

Lecture II.—January 13.—Some of the lecturer's excavations—The tomb of Aristotle and its contents—The Argive Heraeum—Plataea—The great excavations of the Germans at Olympia and Pergamon—The French at Delphi—Specimens of beautiful works of Greek Art which the spade has restored to us—The future of excavation—Herculaneum.

The lectures will be fully illustrated by lantern slides taken during the excavations, and from the works of art recovered.

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FRIDAY, DECEMBER 25, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience, will be delivered on Wednesday afternoons, January 6th and 13th, at 5 o'clock, by Charles Waldstein, Litt.D., Ph.D., Slade Professor of Fine Art in the University of Cambridge, on "Digging for Ancient Art Treasures."

Each Member is entitled to a ticket admitting two children and an adult.

A sufficient number of tickets to fill the room will be issued to Members in the order in which applications are received.

Most of the tickets have now been issued, but there still remain sufficient to supply members who apply for them at once.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

Thursday afternoon, December 10; SIR H. EVAN M. JAMES, K.C.I.E., C.S.I., in the chair.

The CHAIRMAN, in opening the meeting, said that papers had been read before the Indian Section of the Society on subjects of such serious nature as the Famines, Finances, and Provinces of India, but on the present occasion a paper was to be read of a rather lighter vein but still of great interest to all concerned in our Indian dependency. The birds of India had occupied the attention and been illustrated by the pens of many distinguished men in the past, such as Blyth, Jerdon, and A. O. Hume; in more recent years by Oates and Bowdler Sharpe; and, in the present generation, by the author. To one who was as fond of natural history as he (the Chairman) and every district officer was, it was pleasant to think that the mantle of former noted ornithologists had fallen upon Mr. Dewar, who had already given to the world two very interesting works, the first a collection of papers called "Bombay Ducks," and the second on "The Birds of the Plains." After the reading of the paper the audience would have the pleasure of seeing some illustrations, mostly by Captain Fayrer, son of the late Sir Joseph Fayrer, whose "Thanatophidia of India" was well known to many present.

The paper read was—

THE BIRDS OF INDIA.

By DOUGLAS DEWAR, F.Z.S., I.C.S.

Of the birds of India it may truly be said "their name is legion." He who would treat of them in a short paper must perforce confine himself to generalities. I, therefore, propose to devote the time at my disposal, firstly, to a consideration of the general characteristics of the avifauna of India, and then to pass on to some aspects of the study of bird life.

Literary critics seem to be agreed that we who write about Indian birds form a definite school. "Phil Robinson," they say, "furnished thirty years ago a charming model, which all who have followed him seem compelled to copy more or less closely." Mr. W. H. Hudson remarks: "We grow used to look for funny books about animals from India just as we look for sentimental natural history books from America."

In a sense this criticism is well-founded. Popular books on Indian ornithology resemble one another in that a ripple of humour runs through each. But the critics err when they attempt to explain this similarity by asserting that Anglo-Indian writers model themselves, consciously or unconsciously, on Phil Robinson, or that they imitate one another.

The mistake made by the critics is

excusable. When each successive writer discourses in the same peculiar style the obvious inference is that the later ones are guilty of more or less conscious plagiarism. But such an inference is drawn only by those who have not enjoyed the advantage of meeting our Indian birds in the flesh. To those who do possess this advantage it is clear that the birds themselves are responsible for our writing being funny. We naturalists merely describe what we see.

The avifauna of every country has a character of its own. Mr. John Borroughs has remarked that American birds as a whole are more gentle, more insipid than the feathered folk of the British Isles. Still greater is the contrast between English and Indian birds. The latter are to the former as wine is to water.

India is peculiarly rich in birds of character. It is the happy hunting ground of that unique fowl, *Corvus splendens*—the splendid crow—splendid in sagacity, resource, adaptiveness, boldness, cunning, and depravity—a veritable Machiavelli among birds. I might almost say a super-bird.

The king crow (*Dicrurus ater*) is another creature which can be described only by superlatives. He is the Black Prince of the bird kingdom—the embodiment of pluck. The thing in feathers of which he is afraid has yet to be evolved. Like the mediæval knight, he goes about seeking those upon whom he can perform some small feat of arms. In certain parts of India he is known as the *Kotwal*—the official who to many stands forth as the embodiment of the might and majesty of the British *raj*.

When we turn to consider the more outward characteristics of birds, the peacock (*Pavo cristatus*), the monal pheasant (*Lophophorus refulgens*), the so-called blue jay (*Coracias indica*), the oriole (*Oriolus kundoo*), the white-breasted kingfisher (*Halcyon smyrnensis*), the sunbird (*Arachnechthra zeylonica*), the little green bee-eater (*Merops viridis*), and a host of others rise up before us. Of these some, showily resplendent, compel attention and admiration; others, of quieter hues, possess a beauty which cannot be appreciated unless they be held in the hand and minutely examined, for each of their feathers is a poem of exquisite beauty.

At the other extreme stands the superlative of avine hideousness, the ugliest bird in the world—*Neophron ginginanus*, the scavenger vulture. The bill, the naked face, and the legs of this creature are a sickly yellow. Its plumage is dirty white, with the exception of the ends of the wing feathers, which are a shabby black. Its shape is displeasing to the eye; its gait is an ungainly waddle. Nevertheless, such is the magic of wings, even this fowl looks almost beautiful as it sails, on outstretched pinions, high in the heavens.

The Hornbill.

Between the extremely beautiful, and the extremely ugly birds, we meet with another class having superlative attributes—the extremely grotesque. This class is well represented in India. The great hornbill (*Dichoceros bicornis*) and the adjutant (*Leptoptilus dubius*) are birds which would take prizes in any exhibition of oddities. The former is nearly 4½ feet in length. The body is only 14 inches long, being an insignificant part of the bird, a mere connecting link between the massive beak and the great loosely-inserted tail. The beak is nearly a foot in length, and is rendered more conspicuous than it would otherwise be by a structure known as a casque. This is a horny excrescence, nearly as large as the bill, which causes the bird to look as though it were wearing a hat, which it had placed for a joke on its beak, rather than its head. The eye is red, and the upper lid is fringed with eyelashes which add still further to the oddity of the bird's appearance. The creature has an antediluvian air, and one feels, when contemplating it, that its proper companions are the monsters that lived in pre-historic times. The actions of the hornbill are in keeping with its appearance. Each morsel of food is tossed into the air and caught in the bill preparatory to being swallowed. Mr. E. V. Lucas describes the hornbill as the best short slip in the Zoological Gardens. Hornbills are the clowns of the forest.

The Adjutant.

Even more grotesque is the adjutant. This is a stork with an enormous bill, a tiny head, and a long neck, all innocent of feathers. From the front of the neck hangs a considerable pouch, which the bird can inflate at will. Round the base of the neck is a ruff of white feathers that causes the bird to look as though it had donned a lady's feather boa.

It is the habit of the adjutant to stand with its head buried in its shoulders, so that, when looked at from behind, it resembles a hunch-backed, shrivelled-up old man wearing a grey swallow-tailed coat. It looks still more ludicrous when it varies the monotony of life by

kneeling down. Its long shanks then stretch out before it, giving the impression that they have been mistakenly inserted hind part foremost. Its movements partake of the nature of a cake-walk. "For grotesque devilry of dancing," writes Lockwood Kipling, "the Indian adjutant beats creation. Don Quixote or Malvolio was not half so solemn or mincing, and yet there is an abandonment and lightness of step, a wild lift in each solemn prance which are almost demoniacal. If it were possible for the most angular, tall, and demure of elderly maiden ladies to take a great deal too much champagne and then to give a lesson in ballet dancing, with occasional pauses of acute sobriety, perhaps some faint idea might be conveyed of the peculiar quality of the adjutant's movements." If the hornbill be the clown of the forest, the adjutant is the buffoon of the open plain.

Avine Craftsmanship.

When we turn to avine craftsmanship we find no lack of skilled workmen among our Indian birds. The famous weaver bird (*Ploceus baya*) and the less well-known wren warbler (*Prinia inornata*) are past masters of the art of weaving. The tailor-bird (*Orthotomus sutorius*), as its name implies, has brought the sartorial art to a pitch of perfection which is not likely to be excelled by any creature which has no needle other than its beak.

The nests of the various species of orioles are in their way quite as wonderful as those of the tailor-bird. Each is a hammock slung by means of strong fibres (frequently strips of the pliable bark of the mulberry tree) to a forked branch in much the same manner as a prawn net is secured to its wooden framework.

Song Birds.

If there be any characteristic which Indian birds do not possess to a degree it is perhaps the ability to sing. A notion is abroad that the birds of Hindustan cannot sing, that they are able to scream, croak, and make all manner of weird noises; but to sing they know not how. This idea perhaps derives its origin from Charles Kingsley, who wrote: "True melody, it must be remembered, is unknown, at least at present, in the tropics, and peculiar to the races of those temperate climes into which the song birds come in spring." This is, of course, absurd.

Song birds are numerous in India. They do not make the same impression upon us as do our English birds, because, firstly, we are older and, therefore, less impressionable when we first hear them, and, secondly, their song has not those associations which render dear to us the melody of birds in the homeland. Further, there is nothing in India which corresponds to the English spring, when the passion of the earth is at its highest, because there is in India no sad and dismal winter-time, when life is sluggish and feeble.

The excessive joy, the rapture, the ecstasy with which we greet spring in the British Isles is, to a certain extent, a reaction. There suddenly rushes in upon the songless winter, a mighty chorus, a tumult of birds, to which we can scarcely fail to attach a fictitious value.

India possesses some songbirds which can hold their own in any company. Were the shama (*Cittocinla macrura*), the magpie robin (*Copyschus saularis*), the fan-tailed flycatcher (*Rhipidura albifrontata*), the orange-headed ground thrush (*Geocichla citrina*), the white eye (*Zosterops palpebrosa*), the purple sunbird (*Arachnechthra asiatica*), and the bhimraj (*Dissemurus paridiseus*), to visit England in the summer, they would supplant, in popular favour, some of our English song birds.

Fearlessness of Indian Birds.

Indian birds generally are characterised by their fearlessness of man. It were easy to occupy a whole hour in citing examples of this. A few must suffice. Pied wagtails (*Motacilla maderaspatensis*), brown rock chats (*Cercomela fusca*), which some believe to be the "sparrows" of Scripture, sparrows proper, mynas (*Acridotheres tristis*), spotted owlets (*Athene brama*), doves (*Turtur cambayensis*), roller birds (*Coracias indica*), tits (*Parus monticola*) swifts (*Cypselus affinis*), and robins (*Thamnobia cambaiensis*), have all, at some time or other, elected to share my bungalow with me, building in the walls, under the roof of the verandah, or on a window ledge. Similarly hoopoes (*Upupa indica*), and magpie robins (*Copyschus saularis*) frequently have nested in holes in the mud walls of servants' houses in the compound. Tailor birds (*Orthotomus sutorius*), sunbirds of two species (*Arachnechthra asiatica* and *A. zeylonica*) and bulbuls of three (*Molpastes haemorrhous*, *M. bengalensis*, and *M. intermedius*), have constructed their nests amid the leaves of plants

growing in pots on my verandah. In the garden, within thirty or forty yards of the house, the following have brought up their families: ring doves (*Turtur risorius*) paradise flycatchers (*Terpsiphone paradisi*) fantailed flycatchers (*Rhipidura albifrontata*), house crows (*Corvus splendens*), corbies *Corvus machrorhynchus*), tree pies (*Dendrocitta rufa*), crow pheasants (*Centropus sinensis*), paddy birds (*Ardeola grayi*), green barbets (*Thereiceryx zeylonicus*), coppersmiths (*Xantholaema haematocephala*), woodpeckers (*Brachypternus aurantius*), green parrots (*Palaeornis nepalensis* and *P. torquatus*), shikras (*Astur badius*), kingfishers (*Halcyon smyrnensis*, *Alcedo ispida*, and *Ceryle rudis*), babblers (*Crateropus canorus* and *Argya caudata*), kites (*Milvus govinda*), orioles (*Oriolus kundoo*, *O. melanocephala*), king crows (*Dicrurus ater*), and others which I either omitted to notice or fail to recollect.

Verily is the Indian avifauna one of superlatives. Judging from what I have read of the feathered folk that inhabit other parts of the world, it seems to me that the birds of India are more interesting than those of America, Africa, or Australia, and infinitely more so than the poverty-stricken collection found in Europe. This opinion, I would add, is shared by Mr. Frank Finn, whose knowledge of the birds of the world is as great as that of any man living.

Wealth of Species.

Not the least important feature of the avifauna of India is its wealth of species. Oates and Blanford describe over sixteen hundred of these. Among Indian birds are numbered 108 different kinds of warbler, 56 woodpeckers, 30 cuckoos, the same number of ducks, 28 starlings, 17 butcher-birds, 16 kingfishers, and 8 crows.

The richness of the fauna is accounted for by the wide differences in the climate of the various provinces of India, and by the fact that India lies in two of the great divisions of the ornithological world. The Himalayas form part of the Palæarctic region, while the plains are included in the Oriental region.

The feathered folk that dwell in the mountains and valleys of the Himalayan range differ as widely from the denizens of the plains as do the birds of England from those of Africa. The thirty-mile tonga journey from Rawalpindi to Murree transports the traveller from one bird realm to another. In hot, parched, dusty Pindi the most noticeable birds are the kites, sparrows, house crows, mynas, rose-ringed and Alexandrine paroquets, Indian hoopoes, and rollers, bee-eaters, paddy birds, tailor birds, rat-birds, molpastes bulbuls, king-crows, ring doves, little brown doves, orioles, spotted owlets, the seven sisters, koels (*Eudynamis honorata*), robins, white-breasted kingfishers, golden-backed woodpeckers, scavenger vultures, and fantailed and paradise flycatchers.

Of all these, the kites, orioles, mynas, fantailed flycatchers and scavenger vultures are the only ones seen on the well-wooded Murree hills. There, instead of the caw of the house crow the deeper note of the corby is heard. The crescendo shriek of the koel is replaced by the pleasing double-note of the European cuckoo (*Cuculus canorus*). For the eternal "coo-coo-coo" of the ring (*Tutur risorius*) and the little brown doves, the "kokla kokla" of the kokla green pigeon (*Sphenocercus sphenurus*) is substituted. The chuckles and cackles of the spotted owlet no longer cleave the night air, but the silence of the darkness is broken by the low, monotonous whistle of the collared pigmy owlet (*Glaucidium brodiei*). The boisterous rose-ringed and Alexandrine paroquets are replaced by their slaty-headed cousins (*Palaeornis schisticeps*).

The golden-backed woodpecker, the king crow, the coppersmith, the Indian hoopoe, the grey partridge (*Francolinus pondicerianus*), and the Molpastes bulbuls are supplanted in the Himalayas by pied woodpeckers (*Dendrocopus himalayensis*), the ashy drongo (*Dicrurus longicaudatus*), the great Himalayan barbet (*Megalaema marshallorum*), the European hoopoe (*Upupa epops*), the chukor (*Caccabis chucar*), and the black bulbul (*Hypsipetes psaroides*). Some birds found in the plains have no Himalayan counterparts, but as a set-off we find many new forms on the mountains, as for example, the various jays, laughing thrushes, tits, warblers, the white-capped (*Chimarrhornis leucocephalus*) and the plumbeous (*Rhyacornis fuliginosus*) redstarts, the grosbeaks, the ouzels, rock thrushes, greenfinches, pheasants, and the woodcock (*Scolopax rusticula*). But I must refrain from further cataloguing.

How greatly the avifauna of the Himalayas differs from that of the plains is demonstrated by a comparison of the nesting experiences of Colonel Rattray, in the Murree hills, and myself, at Lahore, which may be taken as typical of the plains

of the Punjab. In the course of two years' observation Colonel Rattray found nests of 104 species of birds. I did not keep a record of the two years I spent at Lahore, but I think I may safely say that I saw the nests of over 60 species of birds, and of these only seven are included in Colonel Rattray's list, published in the Journal of the Bombay Natural History Society. Nor is this all. The Himalayas have what Jerdon calls a "double fauna." The birds of the eastern portion are common to the Himalayas and to the hilly regions of Assam and Burma, while those found on the western portion of the range include a large number of European species, and are, to a large extent, common to the Himalayas and to Tibet and Northern Asia. Then, again, the Malabar Coast and the Nilgiris possess not a few species of birds found nowhere else. It is, therefore, possible to divide the Indian Empire into four geographical regions, each having a distinctive avifauna. Such, then, are the birds that render India an El Dorado for the naturalist.

Let us now consider them from three different standpoints. Firstly, from that of the bird-lover, of him who watches the feathered folk chiefly, if not solely, on account of the pleasure he derives from so doing. Then from the standpoint of the biologist, who studies the fowls of the air, as he studies other forms of life, in the hope of elucidating some of the mysteries presented by the natural universe. Lastly, from the utilitarian standpoint of the economist, who concerns himself with birds in order to determine how they may be made to serve best the interests of man.

THE CHARM OF BIRDS.

Mr. W. H. Hudson quotes Sir Edward Grey as saying that the love and appreciation and study of birds is something fresher and brighter than the second-hand interests and conventional amusements in which so many in these days try to live; that the pleasure of seeing and listening to them is purer and more lasting than any pleasures of excitement, and, in the long run, "happier than personal success."

Only those who have come under the sway of the charm of birds can appreciate to what an extent the *joie de vivre* is enhanced by an acquaintance with them. Interest in the feathered hosts, when once aroused in a man, will never flag or wane. Rather will it grow in intensity with advancing years, so that many a man as

"Swift to its close ebbs out life's little day,"

has been able to say, with the late Mr. R. Bosworth Smith, "Birds have been to me the solace, the recreation, the passion of a lifetime." It is not easy to describe in words the nature of the enduring happiness which the love of birds gives. This must, of necessity, vary with temperament. Says Gilbert White:

"To yonder bench, leaf-shelter'd, let us stray,
Till blended objects fail the swimming sight,
And all the fading landscape sinks in night;
To hear the drowsy dor come brushing by
With buzzing wing, or the shrill cricket cry;
To see the feeding bat glance through the wood;
To catch the distant falling of the flood;
While o'er the cliff th' awakened churn-owl hung
Through the still gloom protracts his chattering song;
While high in air, and pois'd upon his wings,
Unseen, the soft enamour'd woodlark sings:
These, Nature's works, the curious mind employ,
Inspire a soothing, melancholy joy:
As fancy warms, a pleasing kind of pain
Steals o'er the cheek, and thrills the creeping vein.'

There are occasions on which watching birds has inspired in me "a soothing, melancholy joy." But, as a rule, the pleasure which the feathered folk give me, is of a more lively and exhilarating nature, not infrequently culminating in mirth and laughter. For this, the birds of India are largely responsible. As I have said elsewhere, the man who can watch the doings of the Indian crow for half an hour without being provoked to laughter should, without delay, apply for six months' leave on medical certificate.

I am sometimes asked, Wherein lies the attraction of birds?

The reply is: "In their sprightliness, their vivacity, their beauty, and their grace." As Mr. F. W. Headley justly observes, "a bird seems to have more life in him than any other living creature."

In a sense birds stand at the head of creation. It is on them that nature has showered a double portion of her good things. Their power of flight gives them a big advantage over their terrestrial fellow-creatures. "Birds," wrote Professor Newton, "have no need to lurk hidden in dens, or to slink from place to place under the shelter of the inequalities of the ground or of the vegetation which clothes it, as is the case with so many animals of similar size." This locomotive superiority, although it must add greatly to the happiness of the life of a bird, has not been all gain. Animals are so constituted that it is only through intense struggle that they advance towards perfection. The fowls of the air, safe in their power of flight, have not been obliged to use their wits to the extent that terrestrial creatures have. Instead of

developing a large brain, they have dissipated their energy in flight, song, and gorgeous plumage. Birds form a backwater in the stream of evolution.

The Scientific Study of Birds.

I have already dwelt upon the richness of the avifauna of India. It is this wealth in number and variety of species which makes it so valuable to the biologist.

Grant Allen has said somewhere that there is no university like the tropics, that no man can be said to be properly educated who has not passed the tropical tripos.

It is significant that the idea of natural selection came to both Darwin and Wallace in the tropics. This great hypothesis revolutionised biology. But since Darwin's day the science has made comparatively little progress. This appears to be in great part due to the comparative poverty of the European fauna. The Americans are more fortunate in this respect. But in the New World the progress of biological science has been greatly hindered by the prevailing belief in America, not only that acquired characteristics are capable of inheritance, but that their inheritance has played an important part in evolution.

Whether or no the explanations I suggest are the correct ones, the fact remains that of late years biology has not made progress commensurate with the impetus given it by the publication of Darwin's "Origin of Species."

Nearly half a century ago Jerdon wrote in the introductory chapter to his "Birds of India": —"The tendency of the present age is to accumulate facts, and not to generalise, but we have now a sufficiency of facts, and want our Lyall to explain them."

Since Jerdon's day things have changed. At present we are almost overwhelmed by theories. Many of these possess little or no value because they are founded on an insufficient basis of fact. Day by day fresh theories are published which would not have been enunciated had their originators graduated in the University of the Tropics.

As an example of the kind of absurdities to which theorising on insufficient evidence leads I may cite Dr. Jenner's explanation of the parasitic habits of the cuckoo. He conjectured that the short stay which cuckoos make in England is the true reason why they do not bring up their own young, as the parent birds would be impelled, by a desire to migrate, to quit their progeny before they were able to provide for themselves. Had that eminent medical man paid a visit to India, and studied the habits of the commonest cuckoo, the koel, he would not have formulated this theory. The koel stays for over six months in those localities where it breeds, so that there can be no question of its having sufficient time to rear up its young.

Neo-Darwinism.

The growth of what is known as Neo-Darwinism is a striking example of the modern tendency to theorise on insufficient evidence. A large school of biologists, headed by Dr. Wallace and Prof. Weismann, declares that all the varied phenomena of the organic world can be explained by the action of natural selection on indefinite and indeterminate variations. I venture to submit that Wallace and Weismann would have but few followers had our European naturalists the advantage of an intimate acquaintance with the birds of India.

Come with me in imagination to a wood on the Nilgiri hills and let us rest there a little, sheltered by the foliage from the rays of the sun, and listen to the voices of the birds. The joyous notes of the bulbuls (*Otocompsa fuscicaudata*) fall unceasingly on the ear, forming the dominant note of the bird choir. Upon these are superimposed a tumult of other sounds — the curious call of the scimitar babbler (*Pomatorhinus horsfieldii*), the mirthful tones of the laughing thrush (*Trochalopterum cachinnans*), the sweet little song of the white-browed, fantailed flycatcher, the softer lay of Tickell's flycatcher (*Cyornis tickelli*), the cheeping of the black and orange species (*Ochromela nigrirufa*), the feeble twitters of the grey-headed one (*Culicicapa ceylonensis*), and a multitude of other sounds.

The Paradise Flycatcher.

While we are listening a fairy-like bird flits silently into view and perches in a leafy tree. This is a paradise flycatcher—a cock in the full glory of his adult plumage. Jet black is his crested head, contrasting sharply with his snowy plumage. Two of his tail feathers, 12 inches longer than the others, hang down like satin streamers. The hen lacks this ornament, and is deep chestnut where her lord and master is white. While we are contemplating him another cock appears on the scene, but he, although possessing the two long tail feathers, is rich chestnut in colour, as is the hen. He is in

the second year of his existence, but, like his white neighbour, has a wife and a nest, on which he spends much of the day. Paradise flycatchers are restless creatures, constantly on the move. These two are soon lost to view amid the green foliage.

But another bird, in its way equally beautiful, has appeared on the scene. Having taken some tiny insect upon the wing, it has alighted on a horizontal branch, and is now bowing gracefully to right and to left, the while spreading out its tail into a fan and singing its lay, which has been likened to the opening bars of the "Guard's Valse." This is the white-browed fantailed flycatcher. We cannot say whether it is a cock or hen, for in this species there is no external difference between the sexes. But its habits are very similar to those of the paradise flycatcher, and, like that form, it builds an open cup-shaped nest. From the same tree a grey-headed flycatcher makes a sally into the air after the "circling gnat." He must have been sitting there some time; but, being inconspicuous, he escaped our notice until he moved.

Let us now saunter on a little, keeping our eyes open for other species of flycatcher, because it is these we particularly wish to see. In one tree we notice, picking insects off the leaves, a flock of minivets (*Pericrocotus flammeus*), the cocks arrayed in black and flaming red, while the hens look equally gay in their gowns of black and bright yellow. On one of the lower branches of the same tree we notice a dumpy little bird with a short square tail, robin-like in colouring but very unrobin-like in shape. It suddenly takes to its wings, circles after some tiny insect, and returns to its perch, and thus we are able to recognise it as the black-and-orange flycatcher. The sexes being alike in plumage we cannot say to which one this individual belongs.

A sharp "chick, chick," followed by a little tune of six notes, betrays the presence of a Tickell's blue flycatcher. Approaching softly the tree whence the song seems to come we soon discover the exquisite little glistening blue red-breasted songster.

We have now seen all the common flycatchers of the Nilgiris save the blue one (*Stephrola albicaudata*), and it is not long before we come upon him. He is an indigo-coloured bird, with whitish underparts. Going a little farther we come upon the brownish-olive hen, with three youngsters, which are brown, spotted with ellow.

The Insufficiency of Natural Selection.

Thus we have seen, living together in one wood, no fewer than six different species of flycatcher, of various shapes and sizes; in some the sexes are alike, in others they display considerable difference. The feeding habits of all are very similar. All dwell in the same environment. There are, indeed, differences in their various nesting habits, but those of the paradise and fantailed species are identical, so that if the colouring of a bird is solely due to the action of natural selection, these two species should be almost identical in shape, size, and colouration. Obviously, then, natural selection fails here to accomplish all that the neo-Darwinians require it to do. It explains much, but not everything. It is but one of many factors in the making of species.

Indian Robins.

The Indian robins present even greater difficulties to those who profess to pin their faith to the all-sufficiency of natural selection. Robins are found in nearly all parts of India, and fall into two species, the brown-backed (*Thamnobia cambaiensis*) and the black-backed Indian robin (*Thamnobia fulicata*). The former occurs only in Northern India, and the latter is confined to the southern portion of the peninsula. The hen of each species is a sandy brown bird with a patch of brick-red feathers under the tail, so that we cannot tell by merely looking at a hen to which of the two species she belongs. The cock of the South Indian form is, in winter, a glossy black bird, with a white bar in the wing, and the characteristic red patch under the tail. The cock of the northern species, as his name implies, has a sandy-brown back, which contrasts strongly with the glossy black of his head, neck, and under parts. In summer the cocks of the two species grow more like one another owing to the wearing away of the outer edges of their feathers; but it is always possible to distinguish between them at a glance. The two species meet at about the latitude of Bombay. Oates states that in a certain zone, from Ahmednagar to the mouth of the Godaveri valley, both species occur, and they do not appear to interbreed.

It seems impossible to maintain that natural selection, acting on minute variations, has brought about the divergence between these two species. Even if it be asserted that the difference in the colour of the feathers of the back of the two cocks is in some way correlated

with adaptability to their particular environment, how are we to explain the fact that in a certain zone both species flourish?

Bulbuls.

A similar phenomenon is furnished by the red-vented bulbuls. This genus falls into several species, each corresponding to a definite locality and differing only in details from the allied species, as, for example, the distance down the neck to which the black of the head extends. There is a Punjab red-vested bulbul (*Molpastes intermedius*), a Bengal (*Molpastes bengalensis*), a Burmese (*Molpastes burmanicus*), and a Madras (*Molpastes hæmorrhous*) species.

It does not seem possible to maintain the contention that these various species are the products of natural selection, for that would mean if the black of the head of the Punjab species extended further into the neck the bird could not live in that part of the country. As there seems to be some intercrossing between these so-called species at places, such as Lucknow, where they meet, I am inclined to regard them as local races of a species, rather than as species of a genus. This, however, does not affect the difficulty which they present to Wallace and his school.

It is tempting to believe that these slight external differences are in some way or other produced by the direct action of the climate to which the various forms are subjected. Unfortunately for this hypothesis, there is evidence which seems to disprove it. For example, the common house-sparrow in India differs from our English sparrows in having white cheeks, but those Indian sparrows which are brought to this country do not lose the white cheek patch as they should do had it been the result of the direct action of the climate in India.

The Red Turtle Dove.

The red turtle dove (*Oenopopelia tranquebarica*) is another Indian bird of great interest to the biologist. It is widely distributed over the plains, and undergoes local migration. Its nesting and feeding habits are identical with those of the other doves common in India—the ring, the spotted, and the little brown dove. But, while in these species the cocks and the hens are alike in external appearance, the red turtle dove displays considerable sexual dimorphism. So great is the difference between the cock and the hen that they have been mistaken for different species. Thus we have in India, living side by side, four widely distributed species of dove, all having similar habits, and in three of these species the sexes are alike in appearance, while, in the fourth, they display considerable differences. Why this should be so, no neo-Darwinian has attempted to explain. Facts such as these seem to be left severely alone by Weismann and his followers.

So-called Mimicry.

The avifauna of India furnishes zoologists with what some, at any rate, of them are pleased to term a most striking case of mimicry. Among birds and beasts certain species have their doubles. Now, when two species, which are not near blood relations, are alike in appearance, and this likeness appears to be advantageous to one of the two species, this latter is said, in biological parlance, to mimic the other. Such mimicry is, of course, unconscious. It is commonly supposed to have been brought about by natural selection. Now, there is in India, a cuckoo—the drongo-cuckoo (*Surniculus lugubris*)—which resembles in appearance the common king-crow (*Dicrurus ater*). Further, the cuckoo is parasitic on the king-crow. Now, this last is, as we have seen, a very pugnacious bird, especially at the nesting season. It guards its nursery with great ferocity. I have watched a pair of these little birds attack and drive away a monkey which tried to climb into the tree in which their nest was placed. Indeed, so able a fighter is the king-crow that some other birds—notably orioles, and doves, which also are very pugnacious, frequently build their nests in the same trees as the king-crow, in order to share the benefit of his prowess. It would be almost impossible to deposit eggs in the nest of a bird so pugnacious as the king-crow without resorting to guile. But the drongo-cuckoo is as like the king-crow in appearance as one pea is like another. Both are small glossy black birds with a longish forked tail. Now, zoologists, seeing how the cuckoo profits by this resemblance, declare that it mimics the king-crow, and that this resemblance has been brought about by natural selection. The theory sounds very plausible, but close inspection reveals its weak points. The king-crow is no fool, so that in order that the cuckoo may delude him into the belief that it is a fellow king-crow the likeness must be fairly close. But the average cuckoo is not in the least like the king-crow in appearance, so that no small

variation in the direction of king-crow appearance would be of any use to it. Hence this remarkable resemblance must in the first place have arisen fortuitously, or rather, causes similar to those which effected the nigritude of the king-crow must have made the ancestral drongo-cuckoo black. But we are as yet more or less in the dark as to what has caused the king-crow to be black, so that we are not in a position to say how it was that this species of cuckoo came to resemble the drongo in appearance.

In attempting to account for any characteristic of an organism by means of natural selection we must be able to explain the utility to the organism of the character in question in its initial stage, and at each subsequent stage of its development. It is not sufficient to show that the character in its final and complete stage is of use to its possessor. This is an important point, which biologists, especially neo-Darwinians, frequently seem to forget.

The black-and-yellow grosbeak (*Pycnorhamphus icteroides*), a bird common in many parts of the Himalayas, resembles the black-headed oriole nearly as closely as the drongo-cuckoo does the king-crow. But since the grosbeak does not descend to the plains, and the black-headed oriole (*Oriolus melanocephalus*) does not ascend the hills, neither can possibly derive any benefit from the resemblance, which, it should be added, extends only to the cocks. Thus there is here no question of mimicry.

Another Indian cuckoo, the famous brain-fever bird (*Hierococcyx varius*), diplays a remarkable likeness to the shikra (*Astur badius*), a sparrow-hawk very common in India. This is said to be a case of mimicry, because the cuckoo is supposed to derive profit from the resemblance. The babblers (*Craleropus canorus*), which it victimises, are said to mistake it for a shikra, flee in terror from it, and so give it the opportunity it requires to gain access to their nests. It is quite likely that the cuckoo does derive benefit from the resemblance. But this is not sufficient to explain a likeness, which is so faithful as to extend to the marking of each individual feather. When a babbler espies a hawk-like bird, it does not wait to inspect each feather before fleeing in terror; hence all that is necessary to the cuckoo is that it should bear a general resemblance to the shikra. The fact that the likeness extends to minute details in feather marking points to the fact that in each case identical causes have operated to produce this type of plumage.

Wallaceism.

It is thus obvious that the problem of evolution is far more complex than Wallace and Weismann would have us believe. Since their doctrine is widely accepted in England to-day, and is inculcated by Professor Poulton at Oxford, I have, in touching upon the study of the birds of India in its scientific aspect, thought fit to bring together a few facts which seem to show that the Neo-Darwinian position is untenable. I would add that I went out to India imbued with the teaching of Wallace, and have abandoned it with reluctance, owing to the many facts opposed to it that have forced themselves upon my notice in that country. I am not attacking the doctrine of natural selection, for I believe that selection is an important factor in the genesis of species. It is to the views of Wallace and Weismann, who have out-Darwined Darwin, that I am compelled to take exception. It seems to me that Dr. Wallace preaches, not Darwinism, but Wallaceism, which is a very different thing.

Economic Ornithology.

The economic aspect of the study of the birds of India is the one likely to commend itself most to the members of this Society. It is certainly the most important from a practical point of view. Unfortunately it is the aspect with which I am the least familiar, since I study birds purely as a hobby.

I take it that all men are agreed that birds as a whole are of incalculable value to man. Were they to disappear from off the face of the earth human existence would be impossible. As things are, insects constitute the dominant group of organisms. "In number of species," writes Mr. Maxwell-Lefroy, Imperial Entomologist to the Government of India, "in actual numbers or bulk, in the sum total of their activities, they outweigh all other forms of animal life at present on the earth." They take toll of all other creatures. The birds are their chief foes. It is due almost entirely to the efforts of the fowls of the air that insects are held in check. To quote Mr. Maxwell-Lefroy again: "Birds are the fluctuating check on insect life, the safety valve as it were; they congregate where they find insects, regardless of their species or habits, and constantly consume the superfluous and superabundant insect life."

But all birds are not equally useful to man. Some are commonly supposed to be positively harmful. Hence the economist does not look upon all with equal favour. He divides the fowls of the air into two classes—the friends and the foes of man. His policy is obviously to encourage the former and to repress the latter.

Unfortunately, it is by no means always easy to determine into which category a particular species falls. A great many birds, as, for example, flycatchers, feed exclusively on insects, and since these latter may as a whole be regarded as man's most deadly enemies, it follows that all purely insectivorous birds are his very good friends. On this point there can be no difference of opinion. Nor can any one doubt that those fowls of the air which subsist mainly on insects are of great utility to man.

Mr. Maxwell-Lefroy writes in his "Indian Insect Pests":—"A large number of birds are wholly insectivorous, a large number are partly so, and every one of these deserves protection and encouragement." In other words, the great majority of birds are useful to man.

Friends or Foes?

But there exists a multitude of feathered creatures that are not purely insectivorous. There are the raptores, which devour other birds, small mammals and reptiles; the vultures which eat carrion; and the birds which feed largely on fruit, grain, or fish. How are these to be regarded? This is a question which can be satisfactorily answered only by considering each species separately, and ascertaining the nature of its food at different stages of its existence, and under various conditions, as, for example, in seasons of drought or excessive rainfall, or at times when the country is invaded by some insect pest, such as the locust. Even when we have succeeded in ascertaining this, we are by no means always able to say whether the bird in question is a friend or foe. Let us, for example, suppose that the species under observation lives chiefly upon grain crops, but that it feeds its young on harmful caterpillars. The caterpillar is a voracious creature, which consumes several times its own weight of food in the course of a day. Thus, the devouring of a caterpillar is a work of merit, which will outweigh the injury done by eating a considerable number of food grains, but who is to say how many food grains go to a caterpillar?

The Sparrow.

Take the common sparrow—a bird which has, of late, come in for much abuse in the columns of *The Times*. It is of great importance to determine the policy to be adopted towards him, for he has spread himself over the greater part of the world. In India he is almost as abundant as in England. If the question: Friend or foe? were determined by votes, I fear that the pushing little fellow would be condemned by a large majority, but I am not at all sure that his condemnation would be just.

We must bear in mind that the sparrow, as his scientific name, *Passer domesticus*, suggests, is a bird of towns rather than of the open country. Now, a town sparrow cannot do much damage to the crops, unless, of course (as many London sparrows are said to do), he takes a holiday in the country at the time when the corn is ripening!

Sparrow Nestlings.

We must not forget that young sparrows in the nest are fed chiefly on insect food. Last year I placed in a cage in the verandah some baby sparrows taken out of a nest in the pantry of my bungalow. The parents soon found them out, and fed them through the bars of the cage. I was able to satisfy myself that the young were fed largely on green caterpillars, which I believe were captured in the kitchen-garden. In each beakful of food carried to the young bird there were not less than three of these caterpillars. By watching the number of times food was taken to the cage, I calculated that the hen, for she does the lion's share of the feeding, brought in something like 540 insects (chiefly caterpillars) per diem to her brood. She fed them on this diet for nearly three weeks, so that the young ones before leaving the nest had swallowed between them several thousands of caterpillars.

Now, we know that the rearing of a family seems to be the normal condition of a sparrow, so that this species performs a very great service to man in the form of insect destruction. Further, the adult birds sometimes eat insects, and this they are likely to do whenever, from some cause or other, insects become unusually abundant, that is to say, precisely at the time when it is most important to man that his little six-legged foes should be devoured. As a set-off to this we must not forget the large amount of food grains that sparrows devour. Moreover, were they less numerous, their place might perhaps be taken

by birds of more undoubted utility to man. Probably the only method of arriving at the truth as regards the sparrow is to exterminate him completely from a given locality, and watch the results. This, I believe, was done about forty years ago in Maine and Auxerre, with the result that almost every green leaf was destroyed by caterpillars in the following year.

It is thus obvious that the determination of the economic value of some birds is not by any means a simple matter. One thing is certain, and that is that no bird should be condemned as an enemy of man until a prolonged and careful inquiry into its habits has been made.

Running through the long list of Indian birds, we meet with some twenty species which the economic ornithologist might perhaps class as "doubtful;" birds which certainly do devour food crops, and which must consequently be classed as foes, unless they render some service to man by way of compensation for the damage they do. These are the sparrows, the various species of crow, the rose-coloured starling, some of the larger finches, the paroquets, the doves, and the geese.

The Crows.

With the sparrow we have already dealt. The crows look upon the ripening crops as a feast prepared for their benefit. But grain forms quite an insignificant portion of their *menu*. They prefer the dustbin to the field, the town to the country. The *corvi* are a source of annoyance to man rather than an economic pest. They are useful if impertinent, scavengers, and undoubtedly destroy a large quantity of harmful insects. When a flight of locusts invades the land they, together with the kites, render yeoman service to the husbandman. Even as a carcase attracts every vulture in the vicinity, so does a swarm of locusts bring together all the crows of the locality. They leave their ordinary occupations to dance attendance upon the devastating host, seizing the insects with their claws and conveying them to the beak in mid air. Each crow devours locusts until threatened by death from a surfeit of food.

In a sense crows and other omnivorous birds are more useful than the purely insectivorous ones. Like the careful housewife, they live upon whatever happens to be in season. If it be locusts, they have locusts for breakfast, locusts for lunch, locusts for dinner. They, therefore, form a highly efficient corps of reservists, ready at a moment's notice to wage war against insect invaders.

The Rosy Starling.

The rose-coloured starling (*Pastor roseus*) spends the greater part of the year in India, although it does not breed there. This bird is said to commit "great depredations" in the corn fields, and, since it collects in immense flocks preparatory to migration, the charge is well founded. But we must not forget that the rosy starling feeds also on grass seeds, insects and wild fruit, especially the mulberry which grows without cultivation, in India. In the United Provinces it is called the Mulberry bird on account of its fondness for that fruit. Chesney states that in Persia it is known as the Locust bird. This name speaks for itself, and shows that the bird is by no means an unmixed evil. On the evidence at present available I do not think we are justified in setting down the rosy pastor as a foe to the husbandman. It should be added that many natives of India eat it.

Finches.

As regards the finches, we may neglect the amadavats (*Sporaeginthus amandava*) and the other tiny species, which do not devour anything so large as a grain of corn. The weaver birds (*Ploceus baya*), however, eat wheat, and Messrs. Haagner and Ivy I notice state that the African species do damage to the crops. But it is my opinion that in India weaver birds subsist, by preference, on the seeds of the various species of tall grasses so common in that country. I do not know from observation on what they feed their young, but, from the fact that they nest in the rainy season, I infer that the young are reared on insect food. It is, therefore, my belief that weaver birds ought to be numbered among the friends of the Indian husbandman. Their relatives, the yellow corn buntings, near relations of the English yellowhammer, may prove to be his foes, since they do not breed in India. They visit Hindustan in large flocks in winter, and levy toll on the ripening corn, but they, like the weaver birds, appear to eat this only when grass seed is not available. Moreover, it is not improbable that they devour insects. Thus the case against them is "not proven."

The rose-finch (*Carpodacus erythrinus*) is another winter visitor which feeds upon the grain crops, but it rarely occurs in sufficient numbers to do much damage, and, as is the

case with its relatives, it seems more partial to the seeds of grass than to those of cultivated crops. Jerdon states that in South India he has observed it chiefly in bamboo jungle. feeding on the seeds of bamboos, whence the Telegu name—" Bamboo-sparrow."

Paroquets.

The case against the beautiful green paroquets is, I fear, far stronger. " Pretty polly" appears never to touch insect food. There is no doubt that he is destructive to cereal crops in India. He has a bad habit of breaking off a head and casting it away after having eaten only one or two grains. He further does harm to fruit gardens. I have seen a rose-ringed paroquet (*Palaeornis torquatus*) flying off with a small orange in his beak. If these birds were very abundant they would undoubtedly become serious pests. As it is they are kept well in check. Hundreds of thousands of these are caught as nestlings, and sold as pets for two annas apiece. The paroquet is the favourite cage bird in India; to have one in the house is considered lucky. Moreover, notwithstanding recent legislation, large numbers of green parrots' skins are exported from India by the plumage merchant. Thus man receives ample compensation for poor polly's larcenies.

Pigeons.

Doves and pigeons, like parrots, never eat insects. Some species subsist almost exclusively on fruit, others on grain. The fruit-eating kinds do but little damage, since they feed mostly on wild figs and other fruit of no use to man. The various species of dove affect groves and plantations of trees rather than cultivated fields, and I have never heard any complaints against them. The blue rock pigeons (*Columba intermedia*) devour food grains, but, as a set-off, they are good birds for the table. They appear to be less abundant in India now than formerly. Sportsmen keep down their numbers. I do not know of any place in India where pigeons are sufficiently numerous to do serious damage to the crops.

Geese.

There remain the geese. These certainly do damage to the green shoots of the various grain crops, but are so useful as food, and afford so much pleasure to the sportsman that their annual influx into India must be regarded as an asset of considerable value. The same may be said of the common quail, which feeds chiefly on grain. Thus, of the 1,600 species of birds found in India we can count on our fingers all those which, on further inquiry, may prove to be foes of the farmer. The vast majority are his very good friends, and should be encouraged by every possible means.

Export of Plumage.

In conclusion, a word on the exportation of plumage. As most people are aware, the Government of India passed, nearly six years ago, a measure prohibiting the export of plumage, other than ostrich feathers, except as natural history specimens to museums. This Act was not passed in haste. The question of the necessity for such legislation on account of the harm done to agriculture by the killing of useful birds, for the sake of their plumage, was raised as long ago as 1869. It was not until 1887 that legislative action was taken. The enactment of 1887 not proving sufficiently efficacious, the more stringent Act of 1903 was passed.

Thus the Government of India has done all in its power for the birds and the agriculturists. Unfortunately, the export still continues, although, I believe, it has been considerably lessened. The law is evaded by the exporter making a false declaration as to the nature of his exports. I am glad to observe that a Bill prohibiting the importation of such plumage into Great Britain is now before Parliament. This Bill, if it becomes law, will render the Indian Act far more effective.

Surgeon-General Bidie, in a pamphlet published eight years ago, gives a list of thirty-two birds which are, or were, captured in South India on account of their feathers. Some of these birds are to be numbered among the best friends of the Indian husbandman. But, inasmuch as the Act of 1903 has come into force since Surgeon-General Bidie's paper was written, I do not propose to make it the basis of the remarks I am about to offer. A safer foundation is that afforded by the sales which have actually taken place in London of recent years. Large numbers of the following Indian birds have been sold in London since the passing of the Act:—Egrets, the "ospreys" of the feather trade, Impeyan or monal pheasants, paroquets, kingfishers, trogons, orioles, rollers, pittas, owls, jungle and peafowl. With the solitary exception of the paroquets, these are all good friends of the Indian ryot. So that, notwithstanding recent legislation, the plume-hunters

are every year draining India of thousands of what Sir Charles Lawson well calls "a watchful and efficient bird police against multitudinous insect thieves." Thus, from a purely economic point of view, apart from the cruelty it involves, the trade in plumage birds is harmful to India.

Extinction of Birds.

There is also the question of the extinction of beautiful birds. Whether there is any danger of this I am not in a position to say, for my stay in India has not been sufficiently long for me to be able to form an opinion of the effect of this bird slaughter on the numbers of the various species. But Sir Charles Lawson, writing in 1900, states that the continuous depredations, of a long series of years, have wofully reduced the means of supply (of birds' skins), as any one may notice for himself when he passes paddy fields, or strolls through silent because birdless, plantations, or forests." It is certainly significant that the beautiful Indian roller, or blue jay (*Coracias indica*) is a rare bird about both Madras and Bombay, while he becomes more plentiful as one goes inland. There seems to be no reason why this species should not thrive right up to the seashore, so that I am forced to attribute his scarcity on the coast near Bombay and Madras to the depredations of the plume-hunter.

The Indictment against the Plume Hunter.

There are three counts in the indictment against this individual. First, that he is causing to become extinct some of the most beautiful of God's creatures. Second, that he is robbing the husbandman of numbers of his most useful allies. Third, that he is guilty of much cruelty. As regards count number one, thanks to the action of the Government, no Indian species, except possibly the monal pheasant (*Lophophorus refulgens*) seems in danger of early extinction. As to count number two, notwithstanding this legislation, the plume-hunter continues to destroy birds useful to the cultivator. There remains the third count of the charge, that of cruelty. Upon this I would lay especial stress, for I am convinced that if ladies had even a faint idea of the cruelty which plume-hunting involves, they would, with one accord, abstain from wearing any feathers save those of the ostrich and various game birds.

Cruelty to Animals.

The low-caste inhabitants of India are, I regret to say, not, as a rule, characterised by kindness to animals. These seem quite unable to appreciate the fact that animals can feel. I have often observed donkeys staggering along so overloaded that at each step their hind legs "brushed," and blood issued from the places where the friction was greatest. I have seen, harnessed to a tonga, horses so exhausted that they could scarcely stand. On one occasion a friend and I walked a considerable portion of the journey from Rawalpindi to Murree in July because some of the tonga horses provided for us had not sufficient strength to pull the vehicle at more than a walking pace. On our way up we actually came upon the body of a horse that had dropped down and died from sheer exhaustion. We reported the matter to the Local Government, and suitable action was taken.

Some Indians use what are known as "thorn bits," that is to say, bits provided with sharp spikes, so that when the reins are jerked these penetrate the flesh of the mouth of the unfortunate steed.

In India fowls are always sold alive at market. The cook, when he purchases a number of them, ties the legs of all tightly together, and, holding the tied-up bundle of legs, he carries the poor creatures home head downwards.

When out shooting I find it necessary to examine every bird picked up to make sure that life is extinct, as otherwise the coolie that carries the "bag" will put living birds into the game stick, and there they will hang suspended by the neck until they die. Since animals are treated thus in everyday life, it is not pleasant to contemplate the kind of treatment meted out to his victims by the professional bird-catcher—a low caste man, brutalised by the constant butchery he perpetrates. He brings down his victim by means of a pellet of dried mud slung from a catapult, and wrapping the poor creature up in his loin-cloth, leaves it to die a lingering death. As likely as not, the bird in question has a nest full of young ones. These starve to death. Even white men are guilty of similar cruelty. Colonel Ryan, in the evidence which he gave, in June, before the Select Committee of the House of Lords on the Importation of Plumage Prohibition Bill, said:—"Last year I knew of another rookery (of egrets) in New South Wales where some brigands went down and destroyed, I

think, about fifty birds. Shortly after it was done we sent a photographer up, who got a very interesting series of photographs taken. He photographed a lot of dead birds and some young ones that died in their nests, and he got one photograph, which is almost unique, of three young birds just with their heads dropping, almost at the point of death."

We have listened lately to much talk about the right of women to vote. I beg to point out that there are modes of exercising political power far more efficacious than an occasional visit to the polling station. Woman—voteless woman—can, if she will, do more than even the British Parliament to prevent the destruction of beautiful birds.

DISCUSSION.

The CHAIRMAN (Sir H. Evan M. James, K.C.I.E., C.S.I.), in opening the discussion, thought all present must have experienced great pleasure in listening to the very graphic account the author had given of Indian birds. Many who had been in India would agree that most Indian birds were exceedingly cheery persons, and that in hot weather, and in the rains, when the climate was rather objectionable, the pursuit of ornithology was one of the very best pastimes to which a young fellow could take. Judging, however, from his own recollections, birds did not always give pleasure. For instance, if one saw one's breakfast being carried from the cook-house to the tent, and a kite swooped down and carried it off in its claws, or if a brain fever bird kept one awake all the night in a hot June, when not even a punka gave relief, with its terrible shrieking, then one wished there were fewer birds in the world. But certainly it was impossible to recommend to a young man, going out to India, a more delightful study than ornithology. Triumphs were to be obtained in that country, in discovering a bird that had not hitherto been known, or, in the jungle, in finding the great hornbill, when she was nesting. The female hornbill, as probably all present knew, nested inside a large hole in a lofty tree. When she was once inside, the male hornbill built up the hole, so that the poor wife could only put her nose out, and there she had to stay till she had laid her eggs and hatched them, while the male hornbill came and fed her according to his discretion. But birds were an incessant source of interest. In the rains, the little black bustard could be seen; he would crow loudly with a sort of gallinaceous crow, and then jump high into the air, four or five feet, to please his ladies. It was a thrilling sight to behold an eagle charging down on a great, fierce cobra. One's sympathies were generally with the eagle, and he had never known a case in which the eagle was not victorious and did not carry off the cobra in his claws. The author had alluded to certain phases of neo-Darwinism, in which he thought the disciples of the giant Darwin, and his almost equally giant colleague, Professor Wallace, had gone beyond their teachers. Ornithologists were divided into field naturalists and cabinet naturalists, and the former sometimes resented the dogmas of the latter. Field naturalists saw the birds, knew their habits, their migrations, and their customs, while the cabinet naturalists only knew about their skins. The great Darwin and the great Wallace were amongst the greatest of field naturalists as well as the greatest of cabinet naturalists; and he was sure that both Darwin were he still living, and Professor Wallace, would welcome any naturalist who carefully observed facts, and would be glad that any naturalist should, even though his conclusions did not exactly square with those held by the other party, fearlessly bring them forward as the author had done. He supposed one ought to stand in a sheet of penitence in the present days, for venturing to say so, but his own views entirely agreed with the author's. It had been his fortune to travel in forests in many parts of the world, and constantly when one saw the tail of the magnificent green trogon, or the humming-birds flashing in the sun, or the monal pheasant and many other wonders of natural history, one felt that although natural selection might account for a great deal, still it was impossible to believe, as modern zoologists were trying to prove, that no other causes were operative in the development of species than natural selection. He was sure the sympathies of the audience were with the author in his remarks with regard to the cruelty which attended the collection of the feathers of birds for the adornment of ladies' hats; and in that connection thanks were due to Lord Curzon, who, in the midst of a very great deal of other work, was able to pass an Act prohibiting the export of beautiful feathers from India. He was sorry to hear from the author that the Act was not worked with thorough efficiency. If that was so, it was to be hoped that the Customs authorities in India would be more on the alert, and that it would be soon found not worth the while of anybody to attempt to export feathers owing to the penalties that they would receive. About ten or fifteen years ago he remembered two Indians, in a part of India with which he was then connected, coming to collect the nuptial feathers of the egret during the breeding season, and also to collect the feathers of the blue kingfisher. The latter were mainly intended for export to China, where they were made use of by jewellers, and the egrets were, of course, intended for the adornment of ladies' bonnets at home. Fortunately in that country the original native rulers had been very fond of shooting and sport of all kinds, and by tradition the paramount power was the owner of all the *ferae naturae*—it was the only part of India in which he knew that to be the case. It was a non-regulation

province, so his officials had no difficulty in persuading those two gentlemen to go away and not interfere with the prerogatives of the Crown. He remembered very well that the two men petitioned, saying, "May we not clear away the birds off only one more lake? We have already been allowed without molestation to clear out the birds from a very large tract of country: one more lake will not matter;" but further depredations were put a stop to. In alluding to what the author had said about birds from the economical aspect, he could not quite agree with him in his respect for the sparrow. It seemed to him that the sparrow had grown in such enormous numbers all over the world that it had become a pest. In New Zealand and Tasmania, where it had been introduced from this country, he had seen it pursuing the gentle birds of the country, which would come and perch on one's knee if one would only sit still enough, and destroying even the goldfinches and other birds introduced from this country; and in England it was destroying the house-martin. He believed it was the case that the scientific advisers of the Royal Agricultural Society had, after very careful enquiry, come to the conclusion that sparrows did more harm than good, and so he for one said, "Away with the sparrow."

Sir George Birdwood, K.C.I.E., said that, moved by the support given by the Chairman to the protest made by Mr. Dewar against the use of feathers as a personal decoration by women, he would reverse the intended order of his remarks on the brilliant paper they had just heard, and begin with a counter protestation against two altogether extraneous points of discontent raised at the end of the paper, and then offer his observations, wherein he entirely associated himself with the hearty encomium of the Chairman, on the intrinsic matter of it. It was really unnecessary for him to say whether women were morally and æsthetically right or wrong in using feathers as personal ornaments. That was a point for them to determine. God had made woman fairer than all else is fair, and more than all things else for the delight of man, and it was her elemental instinct, and her primal duty not less than her privilege, to enhance her innate attractiveness by every means within her reach; and if beyond the natural dower of her beauty she was pleased to raise about herself an enchanted mirage reflected from her artificial paraphernalia of gems, and flowers, and plumage, of every colour,—although the adorning of her with so much art "Is but a barb'rous skill,"—she might wear her feathers for him (Sir George); and the whole procession of suffragettes, "Lysistrata," and "Stella and Violentilla," and Potentilla with Tormentilla, might all have their "Votes for Women:" and manifestly it was for no man to resist her while he continues to slaughter birds and beasts, not only for food and clothing but for mere sport, and sport in its basest and most brutalising form, the inane craze to slaughter something. More serious was his (Sir George Birdwood's) demurrer to Mr. Dewar's indictment of the people of India, even as modified by limiting it to the outcaste, as cruel to animals. This sweeping indictment could not be justified by a hundred instances such as Mr. Dewar had adduced: and considering that throughout Europe lobsters and crabs are thrown alive into boiling water, — and fishes are crimped alive to render their flesh a little more toothsome,—and geese are put to fiendish tortures to make their livers more tasty to a pampered palate,—it is not in any way allowable for us to reflect on alien peoples for immemorial practices and customs we may regard as inhuman. Often what appear to us cruelties on their part, are due to a mistaken sentiment of mercy; and as for the Hindus, judged by their sacred scriptures, and their epic and lyric poetry, and their folklore, no other peoples the world over can possibly be credited with higher ideals of humanity toward the lower animals — beasts and birds, — even toward reptiles, fishes, and insects. If they do pursue practices that appear to us to be hurtful to these dumb creatures, and injurious to their own spiritual well-being and happiness, and we are strongly moved to reprove them, this should be done privately; while the far better way to attain the "pious object" we may have in view, is, on every opportunity, publicly to praise them for their numberless and inestimable good qualities of heart and soul, and thus help to keep them always in the mood to attain to the level of their exemplary ideals, and highest real selves. As to Mr. Dewar's treatment of the subject of his paper,—that left nothing to be desired, if there was no presumption in his so saying. He was no ornithologist, but it did so happen that when stationed in 1855-6, at Belgaum, Kaladghi, and Sholapore, he had sent a collection of 300 birds, skinned and stuffed, made in the jungles about the Ghatpurba river, and of the native State of Sawantwari, and the Portuguese territory about Goa, and throughout the Southern Mahratta Country: and he presented it to the Government Central Museum, of which Dr. George Buist was then Curator. When, however, the Mutiny broke out in 1857, and while he (Sir George Birdwood) was serving in the Persian Expedition of 1856-7, the Museum being wanted for the accommodation of the troops then expected from England, its contents were all thrown into the streets by the Brigadier commanding at Bombay, and nearly all the gay plumaged birds were scattered among those who were pleased to give them hospitable harbourage. But that apology apart, he was quite entitled to say that he, with everyone else present, had listened to Mr. Dewar's paper not only with instruction and interest, but with downright delight. It seemed to him admirable alike in its scientific and literary quality, while Mr. Dewar's enthusiasm throughout, made it perfect for

the inspiration of others who might be attracted by it to follow him in his studies, in the field, or at the desk, of "the Birds of India." If the paper was reproduced in a permanent form he would like it prefaced for the help of these younger students, otherwise unfamiliar with its subject, by a list of previous works on it; and he would venture to particularise: — Major Franklin's "List of the Birds of the Ganges and Vindhian Mountains," in the Zoological Society's Proceedings for 1831; Colonel Sykes' "Birds of Bombay," in the same Society's Proceedings for 1832; Thomas Claverhill Jerdon's famous "Birds of India," published in 1832-34; Allan Octavian Hume's "Game Birds of India," the standard work in its special department on the subject; and Alfred Russell Wallace's "Birds of the Malay Archipelago," incidentally alluded to by Mr. Dewar, and indeed one of the greatest works in the science of ornithology ever published. He would also emphasise Mr. Dewar's reference to John Lockwood Kipling's "Beasts and Man in India," as not only an illustration of the fascinations of the literary treatment of natural history by a man of comprehensive genius and powerful individuality, but an example, quite unusual in our day and generation, of pure Doric English, and of the convincing force of that all absolving, all commanding charm.

Mr. ALEXANDER ROGERS requested the author to make a few remarks with regard to the migratory birds of India, especially those which gave sportsmen so much sport in Western India.

The CHAIRMAN pointed out that the time at the disposal of the author was very strictly limited, and as he had referred a good deal to the economic and other aspects of birds, he had been obliged to leave out from his paper any reference to their sporting and migratory aspects, and also the bibliography.

Dr. JOHN POLLEN, C.I.E., said he felt provoked to rise to reply to the accusation Sir George Birdwood had brought against the author. He had listened very attentively while the paper was being read, and he did not see or even hear a stone thrown at the ladies in the course of it, but he did hear Mr. Dewar implore the assistance of the ladies in repressing a form of cruelty which he was sure everyone deprecated and deplored. Sir George Birdwood also cast a reflection upon the Chairman as one of the murderers of birds in India, and he (Dr. Pollen) must plead guilty to the charge, and felt obliged to range himself on the Chairman's side in that particular. They thus stood in the dock together. The Chairman and himself had shot many birds in India of all sorts, but he could not justify the killing of them except for the general reason that they went out to enjoy themselves, and it had been popularly represented that an Englishman was never happy unless he was killing something. However that might be, he was sure all present had thoroughly enjoyed the paper; he did not know when he had listened to any paper with deeper pleasure than the one which had just been read. It called back to his mind memories of India, and the delight he had experienced from the songs of its birds. Together with the Chairman he had suffered from the attacks of the brain fever bird, but he had forgotten about all those troubles now, and all his memories connected with India were of a melodious description. He was glad that Sir George Birdwood thought it right and proper to vindicate the natives of India from the implied charge of cruelty brought against them. Their form of feeling was different from that of the people of this country. Nothing could possibly induce the natives of India to put a suffering animal out of its pain. Even if a poor bullock lay dying on the roadside, no Hindu would think of killing it. Indians had a higher idea about such matters than the people in this country; and it was not from any desire to cause extra pain that they refrained from putting the animal out of pain, but from some loftier motive of which Englishmen could form little conception. It took a cultivated man like Sir George Birdwood to appreciate fully the meaning of the natives not putting to death animals that appeared to be suffering. He wished to reiterate his appreciation of the delightful paper which had been read, and he would carry away from the meeting, in common with all present, most pleasant recollections which had been revived by it.

Mr. DEWAR, in reply, said that Sir George Birdwood had quite rightly stated that he had paid no attention in the paper to the work of his predecessors in Indian zoology; but that was simply because he experienced the very greatest difficulty in knowing what to say in so short a time on so big a subject. It was almost in despair that he began the paper at all. The title of the paper was not his own choice, but was furnished to him. He remarked at the time that he did not quite see how the subject of the birds of India came within the scope of the Society, as it was not a natural history Society, and he, therefore, felt obliged to say something about the economic aspect of birds, although he knew very little about it. He thought Sir George Birdwood might have mentioned Mr. E. H. Aitken amongst those who had done excellent work on the subject. His "Common Birds of Bombay" was perhaps the finest work existing on popular ornithology, and it was impossible to have a more perfect book, in every way. It only cost about two rupees, and all the common birds were admirably described in it.

On the motion of the CHAIRMAN, a cordial vote of thanks was passed to Mr. Dewar for his excellent paper.

CANTOR LECTURES.

TWENTY YEARS' PROGRESS IN EXPLOSIVES.*

By OSCAR GUTTMANN, M.Inst.C.E., F.I.C., F.C.S.

Lecture I.—Delivered November 23, 1908.

About twenty-five years ago this Society showed its interest in explosives by offering a prize for a process or device calculated to minimise danger during manufacture. Although I once gave a lecture on these dangers, I have not come to claim the prize; thirty-two years of intimate work with explosives have taught me to be modest about inventions. I have, however, endeavoured from time to time to keep the world in touch with this industry, and am grateful to the Council of this Society, which has exercised such a far reaching influence on British industry, for having invited me to review the progress of the last twenty years.

I doubt whether there has been a more important period in the history of explosives than the last twenty years, or one in which more improvements of real value have been brought forward. A short historical retrospect will be very useful in order fully to appreciate this fact. From the time of the invention of gunpowder, or approximately in 1250 (Roger Bacon at any rate knew of it in 1264) until the beginning of the nineteenth century, no other explosive was introduced into practice, although picric acid and fulminate of mercury were known about the latter date. Experiments were carried out by Le Blond, in 1756, in the French Government Factory at Essonne, to produce gunpowder without sulphur, and moreover, a British patent was taken out for this process by Delaval in 1766,† but that was all. In 1788 Berthollet and Lavoisier tried the effect of adding potassium chlorate, and in 1861 Designolle made a powder from potassium picrate and saltpetre, but without much success. In 1846 Schoenbein came forward with his invention of gun-cotton, and in 1847 Sobrero with his nitro-glycerine, but the Austrian Government, which was the only one to try gun-cotton in guns, stopped the experiment abruptly in 1867, their magazines at Hirtenberg having been blown up; and, curiously enough, it is not until that date that Nobel begins to work on dynamite. About the same time the British Government began to experiment with gun-cotton, at the point where the Austrians had left off, and introduced it as a blasting agent into the service, their example being then followed by other Governments. In 1875 Sprengel made his well-known communication to the Chemical Society "On a New Class of Explosives," which has since been named after him, and in 1878 it was again Nobel who invented blasting gelatine. About 1864, Abel and Dr. Kellner, of Woolwich Arsenal, made a granular gunpowder from gun-cotton, and at the same time a sporting powder from nitrated wood, the Schultze powder, was introduced. In Austria it was manufactured under the name of "nitroxylin." Later on, in 1882, Reid made grains of soluble gun-cotton, and hardened them by means of ether-alcohol, calling the product E.C. powder. In my third lecture I shall refer to the important smokeless powder of Friedrich Volkmann made in 1870.

Such was the state of the art in 1886, when simultaneously Eugène Turpin, of Paris, suggested the use of compressed or molten picric acid as a charge for shells, and Vieille carried out his famous experiments resulting in the manufacture of the Poudre B (so named after General Boulanger). At the same time it was recognised that most explosions in coal mines were due to the ignition of fire-damp by the firing of shots, and that it was possible to make so-called "safety explosives," which would considerably reduce this danger.

Hereafter, investigations and inventions came in almost too rapid succession. Unfreezable dynamites, dinitroglycerine explosives, picric acid compounds, and trinitrotoluene explosives, fulminates from aromatic nitro-compounds, phlegmatised fulminate, detonating fuses, and many other varieties were invented. Nitrocellulose, than which there is hardly a more complex substance, was investigated by Cross and Bevan, Häussermann, Lunge, de Mosenthal, Vignon, Will, and others, the stability of nitro-compounds, the properties of nitroglycerine and many other substances were studied by an army of workers. In fact, quite as important results have been obtained since 1886 as in the whole of the previous years. This is due in the first instance to the enormous amount of scientific research and experiment devoted by manufacturers to the study of such questions, partly because they were forced to do so by considerations of national defence, the advent of the rock drill, and by competition, and partly because those who lacked the training for such research could be persuaded by the results achieved to appreciate the work of others. Whilst until a

† Thomas Delaval, British Patent No. 846, of 1766.

generation ago the so-called powder maker was a craftsman, who carefully guarded little *tours-de-main* as valuable trade secrets, and even the inventors of high explosives had to advance in a most empirical way, it is recognised nowadays that only the best scientific knowledge can effect improvements or keep in line with modern developments of the industry. I have stated on another occasion,* how large an amount of engineering and manufacturing knowledge is required for high explosives factories, since these generally make their own prime materials, and work up their waste products, and are therefore chemical works to a much greater extent than explosives works, while, at the same time, the fact that they cover large areas of ground, necessitates the introduction of very special arrangements.

In common with others I once thought, that the use of black powder was dying out, and perhaps this will actually be the case one day; but I confess that I did not reckon sufficiently with the conservative inclination of the miner who, in very many cases, clings most tenaciously to the old black powder. Whilst, for warlike purposes, the use of black powder, and even that of the later brown powder, has become a negligible quantity, blasting powder is still sold to such an extent that, in the mines and quarries of this country alone, nearly 7,000 tons of it, or more than half the total weight of all explosives, were used in 1907.† This, of course, represents only part of the total quantity manufactured in this country, since 3,597 tons of gunpowder of all kinds of British and Irish production, were exported,‡ and a good deal was used for railways, road-making, &c.

There has been practically no progress made in black powder within the last twenty years. Brown powder, which, as is known, contained slack burnt charcoal and a small percentage of sulphur, greatly improved the shooting of large guns, but has gradually given way to smokeless powder even for the very largest guns. A little black powder is still used as a primer for large charges, but even for that purpose it will gradually be replaced by specially prepared smokeless powder. There are still some old sportsmen, who will use nothing but the old fine black sporting powder, and this is more especially the case in remote parts of Germany, Austria, and Italy, whilst in the United States of America professional sportsmen, *i.e.*, those who shoot wild fowl for the market, use black powder because of its cheapness. There is a certain amount of competition going on in this quarter with smokeless powder, and manufacturers of black sporting powder are thereby obliged to make special efforts to produce material of the highest grade only. This has revived interest to some extent in the methods of manufacture of black powder. It is curious to find that the so-called improvements in this manufacture are really revivals of old methods. Thus, for instance, mixing powder in drums has in some instances replaced the use of incorporating mills, and the so-called Swiss or "Nassbrand" (wet residue) powder, which is a powder consisting of perfectly globular grains of uniform size, and of such composition as to give a residue absorbing moisture quickly has again found some favour. The machinery for rounding this powder is still the same as that described 140 years ago.*

The enormous development of the German potash industry and the peculiar requirements of potash and salt mining, have also revived some rough mixtures of black powder-like explosives, of which very large quantities are now sold in Germany. It will be remembered that already in 1865 Neumayer tested a special powder at the Stassfurt salt mines.† Nowadays "Sprengsalpeter" is made, consisting of 75 per cent. of sodium nitrate, 15 per cent. of brown coal, and 10 per cent. of sulphur, or practically a black powder with sodium nitrate instead of potassium nitrate. Another explosive of this kind is "Petroklastite"‡ containing coal pitch and bichromate. Yet another such explosive is "Cahücite," which is our old friend "safety blasting powder," made at Dartford 25 years ago. It contains potassium nitrate, sulphur, lamp black, cellulose, and iron sulphate, and is made by boiling the mixture with water in steam-heated pans. All these powders burn slowly when ignited, and fissure the rock rather than shatter it.

In America, also, large quantities of black powder made with sodium nitrate are used. Labour there is so expensive that work is done

* "Minutes of Proceedings of the Institution of Civil Engineers, 1901," vol. cxliii., Part I.

† "Report of H.M. Inspectors of Explosives for 1907."

‡ Private communication.

* "Recueil de planches sur les sciences, les arts libéraux et les arts mécaniques avec leur explication." Paris, 1768.

† Dingler's "Polytechnisches Journal," 1866, p. 248 and foll.

‡ F. Heise, "Sprengstoffe und Zündung der Sprengschüsse," Berlin, 1904, p. 46.

with this cheap explosive, which on this side of the Atlantic would be carried out with pick and shovel.

Progress of a different kind has been effected by using ammonium nitrate as an ingredient in a powder mixture. This also was tried in France in the eighteenth century with but little result.* Amide powder,† however, made by the Koeln-Rottweil works, and consisting of 40 parts of potassium nitrate, 38 parts of ammonium nitrate, and 22 parts of charcoal, might, but for the advent of smokeless powder, have become a serious rival to black powder. Mayer, of Felixdorf in Austria, also worked in this direction. The Austrian Government makes Wetter-Dynammon as an explosive for fiery mines, which, according to Ulzer,‡ consists of 93·83 per cent. of ammonium nitrate, 1·98 per cent. potassium nitrate, 3·77 per cent. of charcoal, and 0·42 per cent. of moisture, the charcoal grains being 1 to 6 μ in size.

Further progress, although seemingly small, has been made in powder for safety fuses. As is known, safety fuses can be compared to a piece of cord having a fine train of gunpowder in the centre. Competition has in this case also given the consumer the opportunity of demanding a safer and more reliable article than before. It is most important that the fuse should burn at a definite rate per second, and that the powder should not explode in certain parts of the fuse or hang fire or cease to burn in others. Many accidents have occurred in mines through bad fuses delaying the shot or smouldering for hours. Formerly it was not uncommon to use the siftings from mining powder for safety fuses, but the present stringent requirements have compelled all manufacturers to make a special quality of fuse powder of constant composition, density, and uniformity of granulation, in spite of its almost dust-like character.

I shall lay before you later on information concerning safety explosives for fiery mines, and, therefore, will only mention that in every European country the use of gunpowder is prohibited in such workings. Considerable surprise was, therefore, felt when several black powder-like mixtures passed the official test for permitted explosives in this country. Later, when these tests were made more rigorous, these explosives disappeared, but one of them, Bobbinite, passed even the more stringent tests and is on the new list of permitted explosives. According to the official definition it consists of about 64 parts of potassium nitrate, two parts of sulphur, and 19 parts of charcoal, with the addition of 15 parts of a mixture of ammonium and copper sulphates, or alternatively of eight parts of starch and three parts of paraffin wax with a corresponding increase in the other materials. We will examine later on the reasons why such a powder mixture does not ignite fire-damp, whilst ordinary powder does.

Complaints having been made as to the alleged danger of Bobbinite in fiery mines, the Home Office appointed a departmental committee in 1906 to investigate the matter, which came to the conclusion that the use of Bobbinite should not for the present be restricted.* The importance of this explosive may be gauged from the fact that over a million pounds of Bobbinite were used in 1907 in this country. A slow burning explosive, which does not rend the coal too much, has its advantages, and the facts that the miners are used to black powder, and that if the bore-hole be overcharged as usual, Bobbinite does not break up the coal badly, has also assisted in making it popular.

Quite a scare was produced in 1894 by the discovery, made by Major Hellich, that so-called "German saltpetre" contained perchlorate as well as chlorate†, and that Dr. Panaotovic of the Royal Servian gunpowder factory of Stragare was able to prove by the re-examination of old samples, that most of the accidents in his factory coincided with a considerable percentage of perchlorate found in the powder which caused the explosion.‡ Many investigations followed, evidence of accidents seemed to accumulate, the German quarry owners desired to invoke legislation, manufacturers tried to find means to eliminate the perchlorate, and as usual a number of investigators tried to find the best method for proper analysis. We did not take such a serious view of it in this country, but when the alarming foreign statements could not be overlooked, Mr. Bertram Blount and myself considered the case for certain regular large deliveries, and we came to the conclusion that 0·1 per cent. of perchlorate could be fairly fixed as a maximum for the makers of salt-

* Bottée et Riffault, "Traité de l'art de fabriquer la poudre à Canon." Paris, 1811.

† Gaens, British patent, No. 14412, of 1885.

‡ "Mitteilungen des technologischen Gewerbemuseums," Wien 1900, p. 204

* "Report of the Departmental Committee on Bobbinite." London, 1907.

† "Chemiker Zeitung," 1894, p. 485.

‡ "Chemiker Zeitung," 1894, p. 1567.

petre, whilst such a small quantity would be so finely distributed in a well-made powder as to cause no danger, when the usual methods of charging a borehole are observed. All this, however, became superfluous in the end, since Dr. Dupré in this country,* and Professors Lenze and Bergmann in Germany,† showed conclusively, that even with extraordinarily rough treatment, a powder containing perchlorate was no more dangerous than one without it. At the same time Dr. Dupré found, that by heating saltpetre to a temperature of 545°C., the whole of the perchlorate was converted into chlorate, and therefore could be got rid of in extreme cases.

Kelbetz‡ had shown that perchlorate is not uniformly distributed in saltpetre, but tends to agglomerate. There can be no doubt that perchlorate is more explosive than the powder itself, and it therefore occurred to me that this might be the reason why certain English black sporting powders are preferred to foreign ones, which are supposed to be less regular in shooting. These English powders are made with Indian saltpetre, which does not contain any perchlorate, whilst the foreign powders are made with potassium nitrate, which is manufactured by conversion from the Stassfurt potash salts, and always contains perchlorate. Undoubtedly, strong local action will cause a powder to behave somewhat erratically. At the Congress for Applied Chemistry held in Berlin in 1903, Professor Bergmann took special trouble to refute my contention, but two plain facts could not be controverted, namely, that even German sportsmen found certain English sporting powders to be superior, and that when using "German saltpetre" this could not be altered even by the most careful and strict observation of the usual manufacturing routine.

With regard to machinery used in the manufacture of black powder and similar mixtures there has, of course, been very little improvement. Mixing, granulating, and glazing are still carried out in the same way, and for the purpose which they have to accomplish the machines do all that can be desired. A good deal of ebonite was formerly used in connection with machinery for black powder, such as for plates in cake presses, for lining the hoppers of cutting machines, &c. In cake presses there are alternate layers of powders containing sulphur, and of highly insulating ebonite, which remain together under pressure for some time. It is a rule in explosives works that at the approach of a thunderstorm the workers leave their houses, and it is frequently found convenient meanwhile to leave the charge under pressure. This would practically constitute an electric pile, and as a matter of fact several explosions have occurred when after the thunderstorm the workers opened the presses. In one instance, at least, the fact of a long spark having come out of the charge could be elicited from the attendant before his death.

Following a suggestion made by the author twenty years ago, a number of factories have substituted plates of fibre for these ebonite plates with great success. Fibre is a material made of paper pulp with the addition of certain mineral matter and binding material. It has the advantage of not becoming charged like ebonite, of not warping easily, and when warped of becoming flat again by immersion in tepid water, which treatment at the same time softens the material should it have become hard.

Black powder is still sifted in some factories in the old-fashioned frames hung on springs, but more frequently this is now performed in cylinders. In both cases a good deal of dust is produced, which affects the quality of the powder by closing its pores, whilst it also has to be removed as so much waste. One of the improvements effected is the use of a plane sifter. It imparts a slight motion of high frequency and thus the grains are not subjected to violent friction or impact.

Chlorate mixtures have at all times fascinated inventors on account of the large amount of oxygen stored up in potassium chlorate, which can be given off so readily. When Lavoisier and Berthollet tried to make a chlorate powder in a stamp mill in 1788 they made a great show of it, and even two ladies were present. Unfortunately after a certain amount of pounding the powder exploded, and killed an official and the daughter of the Government commissary, who assisted at the experiments.

In this country we have for a long time refrained from licensing any explosives containing potassium chlorate, because such are so easily exploded by impact or friction. A favourite and highly practical test of the late Dr. Dupré, the Home Office adviser, was that

* "Journal of the Society of Chemical Industry," 1902, p. 825.

† "Ueber Perchlorat im Schwarzpulver und über Gefahren bei der Fabrikation und Verwendung perchlorathaltiger Schwarzpulver." Paper read before the V. International Congress of Applied Chemistry in Berlin, 1903.

‡ "Chemiker Zeitung," 1897, p. 587.

of giving the explosive a glancing blow with a broomstick on a wooden floor; chlorate explosives hardly ever stood this test. There was also but little inducement to make these explosives on a commercial scale because potassium chlorate was dear and, therefore, powders made therefrom would hardly have been able to compete with other equally powerful explosives. With the advent of electrolytic methods for the manufacture of chlorine, potassium chlorate and the like, chlorate explosives were brought within easy reach of the trade, and, in fact, the present price of electrolytic potassium chlorate will, under certain conditions, permit the economical manufacture of suitable explosives. Hence greater efforts were made to render chlorate explosives more stable, so as to pass the Home Office test, and ultimately success was attained by the addition of some oil. Its function is evidently to so surround the potassium chlorate that, when mixed with carbonaceous matter, this becomes less sensitive. The addition of greasy matter to chlorate explosives is not at all a new idea. In 1867 already, F. Hahn added spermaceti to a gunpowder containing chlorate.* In 1880, Tschirner† employed tar, and in 1882, Professor Himly‡ patented the use of a solution of hydro-carbons, which idea was again applied by Lyte and Lewall. Fraenkel, in 1888, used naphthalene and paraffin; § Brank, in 1891, took linseed oil, || and many other explosives containing hydrocarbons and tarry substances may be mentioned which were the forerunners of the present-day chlorate explosives. However, a practical explosive was ultimately obtained in Cheddite, patented by Mr. Street,¶ and so called, because it was first made in Chedd, in Switzerland. The more usual variety is known abroad under the name of Cheddite 60 bis, and its composition is 80 parts of potassium chlorate, 13 parts of mononitronaphthalene, 2 parts of dinitrotoluene, and 5 parts of castor oil, whilst, in this country, the proportions of mononitronaphthalene and dinitrotoluene are reversed.

It is interesting to observe how the same old mixtures are proposed over and over again with slight alterations only, in order to qualify for a patent. Potassium chlorate with some carbonaceous matter like charcoal, sugar, starch, glycerine, flour, or sometimes a vegetable or mineral oil and the like occurs again and again. One patent* is of special historical interest since it proposes the use of "Maltha" as an ingredient. The patentees came from California, an English-speaking country, and therefore it might be supposed that the name was not unfamiliar in England, but this appears not to have been the case. I recollected, however, a passage in Roger Bacon's "Opus majus" as follows:—"Nam Malta, quae est genus bituminis et est in magna copia in hoc mundo, proiecta super hominem armatum comburit eum." ("Thus Malta, which is a kind of bitumen, and exists in large quantities in this world, when thrown on an armed man, burns him to death.") It seems therefore, that the *Mayflower* took with her some old-world expressions and adopted them to the new world.

The latest surprise is that in 1908 a chlorate explosive has been licensed as a safety explosive in this country under the name of "Colliery Steelite;" it consists of 74 parts of potassium chlorate, 25 parts of oxidised resin and one part of castor oil.

The electrolytic chlorine industry has also made possible the manufacture of pure perchlorates and more especially of ammonium perchlorate, which presents many advantages, although the objection has been raised that explosives containing this ingredient generate fumes of hydrochloric acid in the mine. So far only Yonckite, a Belgian explosive, containing in addition to perchlorate, potassium nitrate and mononitronaphthalene, and a safety explosive made by the Carbonite Syndicate at Schlebusch under the name of "Permonite" have come into use.

Another class of explosives, which was from time to time used for ordinary blasting purposes, and of which very little has been heard in this country, are the Sprengel explosives. You have all heard of "Rackarock," which was employed in the blasting of the Hell Gate rocks, near New York. Until the last decade it was hardly used anywhere except in America, but on building the first Chinese railways the Americans were able to introduce it.† It seems so simple to take powdered potassium chlorate, fill it into cartridges or linen bags, and then pour nitrobenzene on it. Nevertheless this would

* British Patent, No. 960, of 1867.
† British Patent, No. 447, of 1880.
‡ British Patent, No. 1969, of 1882.
§ British Patent, No. 13789, of 1888.
|| British Patent, No. 5027, of 1891.
¶ British Patent, No. 9970, of 1897.

* Quinby, Sharps, and Greger, British Patent, No. 4781, of 1902.

† Károly Gubányi. The Rackarock Blasting Powder. "Magyar mérnök és épitész egylet közlönye," 1901, p. 165.

really be manufacturing an explosive either in the pit or near it, under conditions which could not be easily regulated, and therefore it could not be authorised in most countries. In China and Siberia no such objection was raised, hence it is not suprising that a number of explosives were patented by Russian inventors, all of which closely resemble Sprengel's original explosives. One of these is now licensed in Italy.

A novel ingredient was introduced by Winand,* who mixes tetranitromethane with petroleum or other carbonaceous matter. Tetranitromethane (nitrocarbon CN_4O_8) crystallizes below 13°C. in white needles, and boils at 126°C.; it is not acid, does not mix with water, and might therefore be useful as an ingredient in other explosives.

Some of the Sprengel explosives are very powerful, and not without advantage, but it is always somewhat difficult to manipulate them with safety and cleanliness.

A new departure was made in 1899, when Dr Richard Escales, of Munich, invented the first aluminium explosive. The use of mangenese dioxide as an ingredient of black powder-like mixtures for the purpose of augmenting the available oxygen has often been proposed, and, as can readily be understood, without success. In 1888 already Chapman patented the use of magnesium in cap composition,† in 1898 Weiffenbach, of Munich, proposed the admixture of aluminium to fireworks,‡ and in the beginning of 1899 Friese-Green and Knell vaporised magnesium in a gun by passing an electric current through the charge.§ These were the only early attempts to utilise light metals in explosives, until Escales showed that the addition of aluminium or magnesium very considerably increased the temperature of explosion and thereby the explosive force. His explosive was patented under the name of Wenghœffer,‖ and is now I believe manufactured together with a similar explosive invented independently in 1900 by Ritter von Dahmen,¶ and since known under the name of "Ammonal."

Ever since, aluminium has been taken as an ingredient in almost any kind of explosive. Theoretically it would be of very great value, but in practice the high price of aluminium powder and the possibility of oxidation under suitable conditions have somewhat militated against it. It is, however, used in Austria-Hungary for filling shells, for which purpose it seems well suited, not having given any trouble during ten years of storage, although I am told they sometimes fail to explode. It is also on the special list of the British Home Office as an explosive for fiery mines.

Other metals might have a similar or even a better effect than aluminium. Thus in 1900 already Désiré Korda, of Paris, and the author have considered the possibility of using ferro-silicon, which can now be made up to 100 per cent. purity, and would readily oxidise. Its very great hardness, the difficulty of making a fine powder, and the possible danger arising from the presence of a hard, gritty substance, however finely divided, did not encourage further experiments. It has nevertheless been the subject of patents by others in 1904, 1905 and 1907, but so far, I believe, without success. In addition to the above-mentioned metals the use of iron, silicon, silicon carbide, zinc and its alloys, copper, and also the rare metals has been patented.

In his patent of 1871 on the explosives bearing his name,* Professor Hermann Sprengel, F.R.S., said, seemingly without reference to the rest of the patent, "I also employ picric acid," but in his famous lecture delivered in 1873, before the Chemical Society, he said distinctly:—"Be it noticed here, that picric acid alone contains a sufficient amount of available oxygen to render it, without the help of foreign oxidisers, a powerful explosive, when fired by a detonator. Its explosion is almost unaccompanied by smoke." As a matter of fact, Sprengel did fire some shots with picric acid, at Messrs. John Hall and Sons factory, in Faversham, in 1871, but was not encouraged by the Service to pursue his experiments.

Nothing further was heard of picric acid until 1886, when, as mentioned before, Eugène Turpin, of Paris, showed how to compress or melt it for use in shells. The French Service used picric acid, mixed with collodion to give it greater density under the name of Melinite. Later on it was compressed, but ordinary detonators failed to explode it with safety, and the expedient devised by Alberts and the author, to use a primer of dry gun-cotton was too inconvenient. The picric acid had therefore to be melted, in which state it can be more readily exploded by detonators, and has a density of about 1·65. Picric acid

* British Patent, No. 26261, of 1907.
† British Patent, No. 16997, of 1888.
‡ British Patent, No. 7579, of 1898.
§ British Patent, No. 11345, of 1899.
‖ British Patent, No. 24377, of 1899.
¶ British Patent, No. 16277, of 1900.

* British Patent, No. 2642, of 1871.

melts at 122·5°C., and must therefore be either heated in an oil bath or by high pressure steam, or in a special "stove." Melting it at such a high temperature is very inconvenient and is not without danger, hence use was made of the well-known phenomenon, that a mixture of two substances of high melting points has nearly always a lower melting point than that of either its constituents. Girard* has given a long list of the melting points of explosive mixtures of this kind, which, coming from such an eminent chemist, deserves to be kept on record. A few characteristic mixtures are the following:—

Mixture in equi-molecular proportion of	M.P. Degs. C.	M.P. of Mixture. Degs. C.
Trinitrophenol	122	49
Nitronapthalene	61	
Trinitrophenol	122	47
Dinitrotoluene	71	
Trinitrophenol	122	70
Trinitrocresol	107	
2 Trinitrophenol	122	78
1 Trinitrocresol	107	
2 Trinitrocresol	107	80
1 Trinitrophenol	122	

Almost every country has adopted picric acid as a disruptive agent under a different name, and differences in composition consist merely in the addition of an ingredient to reduce the melting point. Such additions are nitronaphthalene, camphor, dinitrotoluene, &c., and the names are Melinite, Lyddite, Pertite Shimose powder, Picrinit, Ecrasit, &c.

Besides having a high melting point, picric acid is inconvenient in other ways. Left in contact with metals or oxides it forms very dangerous picrates, hence the necessity of varnishing the interior of shells, giving special protection to the primers, and generally taking the utmost precautions to prevent access of foreign bodies whilst the acid is in the molten state. Picric acid has an intensely bitter taste (which is still more pronounced in the inky smoke of burning picric acid) and, therefore, its manipulation is not very pleasant, it also imparts a fairly fast yellow colouration to the skin, which in some parts has given the nickname of "canary birds" to the workers in picric acid. (I have found in one factory common salt was used for removing the yellow colouration from the skin, but why it should do so is not quite clear.) When used together with other materials it must be remembered that being an acid it is liable to displace other acids, for instance it sets free nitric acid from nitrates and, therefore, while picric acid might be useful for increasing the power of certain explosives, it would actually decompose them.

* British Patent, No. 6045, of 1905.

In order to obviate these drawbacks Hauff had proposed the use of trinitroresorcine* and the Chemische Fabrik Griesheim that of trinitrobenzene,† and trinitrobenzoic acid.‡ These substances were not favourably received, but trinitrotoluene has within the last few years come very much to the fore, and also possesses a great many good qualities. Its melting point varies between 72° and 82° C. It may be handled with almost perfect safety, if pure it does not give off noxious fumes on melting, is quite stable, does not combine with metals and generally has no acid properties. Like picric acid it is only slightly soluble in cold water. It is slightly less powerful than picric acid, which is rather an advantage, since the latter frequently pulverises a shell, instead of bursting it into a number of fragments sufficiently large to have destructive effect. Trinitrotoluene is very easily detonated. I have been able to explode it in the form of powder with a No. 3 detonator only (0·540 gram. of fulminate composition).

Trinitrotoluene has been introduced into the French Service under the name of Tolite. The Spanish Government call it Trilit. The Carbonite Works of Schlebusch are introducing it into other services under the name of Trotyl, and Messrs. A. and W. Allendorff of Schoenebeck, under the name of Trinol, whilst other factories retain the name of Trinitrotoluol.

According to Beilstein, there are three isomers of trinitrotoluene, the modification 1-2-4-6 $[C_6H_2\ CH_3\ (NO_2)_3]$ resulting in large quantities, and being the one used. Its melting point when very pure is 81° to 82° C., and this is demanded for military purposes, but for use as an ingredient in blasting explosives, for which it has found great favour, a lower melting point (77° to 79°) is sufficient. The solidifying point of very pure trinitrotoluene is 78¾° C. The 1-3-4-6 (β) and 1-2-3-6 (γ) modifications with melting points of 112° and 104° respectively, are not used, and special means have to be employed to eliminate them. On the other hand, it is affirmed that an 1-2-3-5 isomer (not mentioned in Beilstein) is intentionally left in the finished trinitrotoluene by one factory, and the advantage claimed that thereby the fused mass solidifies more gradually, giving a higher

* British Patent, No. 9798, of 1894.
† German Patent, No. 79477, of 1893.
‡ German Patent, No. 79314, of 1893.

density on account of the reduced liability to form pores. This advantage can be secured also in other ways, and may be counteracted by a reduction of the melting and solidifying point.

The manufacture of trinitrotoluene is carried out in stages, like that of most aromatic nitro-compounds. Great care has to be taken to purify the toluene, since that usually found in commerce contains benzene and other compounds. Nitration is effected in enamelled iron vessels, and purification of the higher nitrates, which cake together during nitration, has to be performed with some care. Washing is usually completed in centrifugals. In order to obtain the best quality, melting between 80° and 81° C, trinotrotoluene made from purified toluene, and having a melting point of 77° to 78° C, is recrystallised from alcohol in vacuo. The machinery for effecting this is not very complicated, but always specially designed. In this country alcohol is somewhat dear and inconvenient to use in spite of facilities afforded for obtaining it duty free, and petroleum benzene is therefore employed for recrystallising the trinitrotoluene; it is said, however, that a slightly darker colour is imparted by this method to the product; to this objection is taken in some countries.

From investigations made by Dr. Dupré and others, it is known that the manufacture of nitro-compounds from benzene is, to a certain extent, inconvenient and even detrimental to health unless the precautions laid down in the Home Office regulations are taken. The manufacture of toluene nitro-compounds has to be effected under similar precautions, toluene and benzene being closely related as regards their properties. As is the case with all nitro-compounds, decomposition and even fires may occur during nitration if the reaction is allowed to proceed too vigorously. The dust from trinitrotoluene is not bitter, like that of picric acid.

The density of trinitrotoluene, when loose, being 1·500, and when molten, 1·600, means have been devised to increase it. Rudeloff* obtains a density of 1·85 to 1·90 by making a plastic substance from trinitrotoluene and potassium chlorate with a gelatine made from dinitrotoluene and soluble nitrocellulose. Bichel makes a plastic compound with collodion cotton, liquid dinitrotoluene, and larch turpentine, calling it Plastrotyl.† Messrs. Allendorff mix the trinitrotoluene together with some lead nitrate or chlorate with a gelatine made from dinitrotoluene and nitrocellulose, and call it Triplastite. This is an improvement on the way the French Government made Melinite with collodion, or Wolff and Co. filled cut gun-cotton slabs into shells with paraffin wax. Bichel also melts the trinitrotoluene, and after first exhausting all occluded air, compresses it by introducing compressed air above it.* Bichel has in this way obtained densities up to 1·69. Rudeloff presses it in hydraulic presses, under a pressure of 200 to 300 atmospheres, whereby it obtains a density of 1·7, and can be cut and worked like gun-cotton. For the purpose of facilitating detonation some loose trinitrotoluene is used as a primer. Trinitrotoluene is also used in detonators, of which further mention will be made later on.

* "Zeitschrift für das gesamte Schiess-und Sprengstoffwesen," 1907, p. 4.

† British Patent, No. 16882, of 1906.

Another new explosive for filling shells is used in Spain under the name of Tetralit.† It is said to be made from tetranitromethylamine, and to be more sensitive than trinitrotoluene, but very little else is known.

The use of picric acid for filling shells has necessitated the use of a special primer, because picric acid cannot be detonated with certainty by ordinary detonators. In this country, picric powder is used for such primers, and is made of ammonium picrate and potassium nitrate. This is nothing but Brugère's powder of the nineteenth century.‡

During the last three or four years, newspapers contained accounts of trials with a new explosive, at first called Vigorite, and now Bavarite, the invention of Professor Schulz and Mr. Gehre, which is said to cost only one-third as much as other explosives, and to be ever so much more powerful. On examining the patent,§ one finds that this is nitrated solvent naphtha, a somewhat indefinite mixture of various compounds, giving on nitration a mixture of nitro-mesitylene, nitro-cumol, and other substances. The inventors have, in a later patent,‖ indicated means to purify the solvent naphtha, and the new nitro-compound made therefrom is evidently now on trial in Germany. It must be embarrassing to the inventors to see such improbable accounts of manufacturing costs and exaggerated effects produced by the explosive, published in newspapers.

* British Patent, No. 19215, of 1906.

† Zeitschr. für das gesamte Schiess-und Sprengstoffwesen 1908, p. 308.

‡ "Comptes Rendus," vol. 69, p. 716.

§ British Patent, No. 5687, of 1905.

‖ British Patent, No. 19565, of 1907.

QUARRYING IN BELGIUM.

Belgium is rich in various kinds of stone and marble. The quarrying industry employs over 37,000 men, and its annual output exceeds £2,500,000. The most important quarries are in the provinces of Hainaut, Liège and Namur, these furnishing seven-eighths of the total stone quarried in Belgium. The products are freestone, limestone, and paving-stone. The American Consul at Liège says that the blue stone is the best known, and is serviceable for building and ornamental sculpture, being probably the most important product of this class of quarries. The quarries of Soignies, Ecaussines, and Sprimont are the most noteworthy in this connection. These are provided with powerful modern machinery, and employ a large number of workmen. They have also attached to the quarries, apprentice workshops, where young workmen receive practical and theoretical training in stone-cutting and sculpture. The quarries of Belgium furnish a great variety of marbles, which stand rather high in the market. Of black marbles, there are three distinct groups, the first furnishing a marble much in demand, even outside Belgium, which is used in the manufacture of clockcases and mosaics. The "Noir fin de Golzinnes" is valued on account of its purity, the high polish it is capable of receiving, and its adaptability to the carver's chisel. The second group produces a marble that is soft and easily carved, and the third is a deep black, close-grained stone, serviceable for flooring slabs, plinths, window facings, and fireplaces. There are many varieties of red marbles, which are used mainly in large work, such as altars, columns, fireplaces, and window sills. Blue marble, so-called, is used generally for decorative work and paving. The "florence lilas" is very much in demand. The marbles most used in Belgium are the Sainte Anne blue, the red mottled, the Belgian black, and the "granit." The blocks are often shipped in the rough, but it is more customary to finish them at the quarries, the workmen enjoying a reputation of being especially clever in this class of work. The production of porphyry paving stone blocks, sandstone, and calcareous stone is second in importance in Belgium. The slate quarries of Amblere have been worked, from time immemorial, as material for razor hones. The stones are cut in parallelopipeds, the under side of which is composed of slate, while the upper surface consists of the sharpening stone. The stone is exported chiefly to Germany, but some goes to the United States. Limestone is found generally distributed throughout the country. Limekilns are plentiful, and are confined to no particular locality, although those of the Provinces of Hainaut, Namur and Liège, are those only worthy of being mentioned as industrial enterprises. Potter's clay is found generally throughout the country. That found on the Rupel, and in the neighbourhood of Courtrai being used in the manufacture of tiles, drainage pipes, paving blocks and bricks. Chalk is extracted in large quantities at St. Vaast, and at Trivieres.

HOME INDUSTRIES.

London Passenger Traffic.—A generation ago the London road passenger carriage was a highly profitable industry, but now the profit has gone, and nearly all the purveyors of such traffic are working at a loss that, in most cases, may be described without exaggeration as ruinous. Underground railways, tubes, 'buses give little or no return upon capital, and if taxi-cabs are doing better, it is largely because the supply is a long way behind the demand, but only for the moment. It may be safely assumed that, in the course of the next two or three years, an immense number of these cabs will be put upon the streets, and the consequent competition may be expected to reduce very materially the earnings of those now on the road. Moreover, although the existing companies claim to be making large profits, they have only been at work a few months, and there is reason to question whether the sum they have set aside for depreciation is anything like sufficient. The condition of the omnibus companies is almost desperate, and it is primarily due to the substitution of the petrol for the horse 'bus. Each horse 'bus was worked at a certain definite profit per 'bus mile, each petrol 'bus is worked at a definite loss. If the horse 'bus pays and the petrol 'bus does not, it may be asked why not cut the loss, sell the stock of motors for scrap iron, and revert to horse 'buses. That, however, is not a practicable course. The horse tram and the horse 'bus are doomed. Electricity will supersede them as steam superseded the mail coach. There seems no immediate probability of any permanent working arrangement being come to between the various bodies which now compete for the passenger traffic of the London streets, and it looks as if they will be all brought to bankruptcy in their endeavour to run one another off the road. The remedy would seem to lie in higher fares all round and an improved type of vehicle for the 'bus companies. The ideal type is the electric 'bus, and it may be confidently assumed that this will be forthcoming in time. It has more than once been announced that inventors have solved the problem of the light, portable battery, and whenever this discovery is given to the world the profitable motor omnibus for London will have become possible. It must not be forgotten that the motor car in its fourth or fifth year was a very primitive machine as compared with the present vehicle, and the motor 'bus has hardly reached its fifth year.

The Miners' Eight Hours' Bill.—This Bill has now become law, the Lords having passed it with only one important amendment. The Act has little resemblance to the Bill as originally introduced by the Home Secretary. It was then simply an Eight Hours' Bill. After further inquiry, Mr. Gladstone remodelled the miners' proposals. It does not at once establish an eight hours day. The miner has to be "wound" down and "up" the shaft. This

process takes an amount of time variously estimated at twenty minutes, half an hour, and forty-five minutes—say, half an hour. As the Bill originally left the Commons, for five years both windings were excluded from the legal eight hours, but at the end of that period one only of the windings, namely, the time occupied in getting up or down, was to be included in the statutory eight hours, but this was rejected by the Lords. The Act gives thirty days for overtime, so as to enable the coal trade to handle the seasonal fluctuations in the demand for household coal, and it nowhere takes effect before July of next year, while in Durham and Northumberland a whole year is allowed to the masters to prepare for the new conditions. Expert opinion is sharply divided as to the probable effect of the Act. Time only can decide the point, a momentous one for British industry.

Wages and Unemployment.—Meantime Sir Hugh Bell has recently given some striking figures as to the amount of money paid by owners of collieries, and other great enterprises, in wages, and the effect of idleness on the part of both employers and employed on the prosperity of the country. In his speech as chairman of the Horden Collieries, Limited, Sir Hugh Bell stated that he had found, by careful examination, that about 75 per cent. of the gross earnings of a great undertaking like the Horden collieries is paid to *employés*, about 70 per cent. in actual wages and about 5 per cent. in salaries. Roughly, according to Sir Hugh Bell, the artisan earnings of the United Kingdom amount to £750,000,000 per annum as nearly as they can be estimated with the present imperfect data. The workpeople of the Horden collieries idle about 10 per cent. of their time. If, Sir Hugh Bell contended, instead of idling they worked they would earn 10 per cent. more money, and if the same thing is true of all the artisans of the United Kingdom, 10 per cent. of £750,000,000 would be £75,000,000 lost to the income of the United Kingdom through increasing salaries. Sir Hugh Bell added that what is true of the employed is equally true of employers. They idle a good deal also, and in idling they waste a vast sum of money. Sir Hugh Bell's contention is that the real cure for the unemployment which unfortunately is so general is harder work on the part of both employer and employed, which would mean greater production of wealth for the country. It may, however, well be questioned whether the practice of the men at the Horden collieries represents the average action of the workmen of the United Kingdom. Notoriously colliers take a lot of holidays. The nature of their work underground explains and goes far to justify it. And workmen in other industries are at play much oftener than in years gone bye, but few of them come up to the collieries in this respect. Nor will it be generally admitted that the longer time given by the working-classes to recreation nowadays is an unmixed evil.

Investment and House-Purchase Companies.—The circular just issued by the Board of Trade with reference to bond investment and house-purchase companies may serve a useful purpose. The Board has received many complaints from persons who have invested their savings in these companies, and there is abundant evidence of dissatisfaction. The usual course followed by a company of this kind is to offer bonds or certificates for subscription, and to contract to pay the subscriber a lump sum at the end of a period of 10, 20, or 30 years in return for monthly subscriptions of a fixed amount payable by the subscriber. In some cases the subscriber has, in addition, after the subscriptions have been paid for a comparatively short period, the right to an advance from the company up to the nominal amount of the bond or certificate for the purpose of buying a house, subject, however, to the condition that the advance shall in no case exceed the value of the house. The bonds or certificates always contain a penalty for failure to keep up the subscriptions, and in many cases this penalty is the absolute forfeiture of all moneys paid by the subscriber. The complaints fall, for the most part, under three heads—(1) The subscriber wishes to draw out what he has already paid in, but finds that the terms of his contract do not allow him to do so; (2) The subscriber cannot continue his payments and finds that the whole or part of what he has already paid is liable to be forfeited to the company if future payments are not kept up; (3) The subscriber enters into a contract to purchase a house, and thinks that he is, therefore, entitled to an advance from the company up to the face value of his bond or certificate, but finds that the company's surveyor places a lower value on the house than the price agreed to be paid, and he is, consequently, unable to complete his purchase. The advice of the Board of Trade is that intending subscribers should "find out exactly the conditions as to the withdrawal of payments before the end of the period for which the payments are to be made, and as to the risk of forfeiture." It is excellent advice which has been given numerous times by public writers. If it were followed there would be few complaints, for all these bonds and similar companies state the conditions upon which they do business very plainly upon policies and in other ways. Unfortunately, the persons concerned will not study the printed matter sent to them. They prefer to accept the assurances of canvassers, who are often unscrupulous, and they pay the penalty usually exacted from those who risk their money without intelligent inquiry.

The Cotton Industry.—So much is heard now-a-days about British failure in the industrial world that it is quite cheering to read statistics like the following, taken from the evidence of a witness before the Committee of Ways and Means at Washington. "When we think of our progress in the abstract," said this witness, referring to the American cotton industry, "it looks good, but when we compare it to

that of England, we are going slow. England puts up about 8,000,000 new spindles. She goes into fine yarns. She builds the Assouan Dam, and grows enough cotton there to supply all of these mills. Being on fine yarns, it takes but a few bales of cotton compared with the coarser yarns. . . . . We spin about 2,000,000 bales of cotton in the south, and England runs almost as many spindles on the product of the soil that she has put into cultivation in Egypt —250,000 or 300,000 bales are enough, because the numbers are so fine."

NOTES ON BOOKS.

Chapters on Papermaking. (Volume V.) By Clayton Beadle. London: Crosby, Lockwood and Son. 5s. net.

The work described in this volume was undertaken for a series of articles which were published in the *Papermaker*; and the actual tests from which the conclusions are drawn were made by papermakers and engineers for purposes of their own, but for the most part on lines suggested by the author. It deals with the theory and practice of beating, describing the early beating appliances, the Hollander, its construction and mode of action, trials with breakers, Reed beaters and Kingsland refiners, methods for determining the "wetness" of broken stuff, &c. The book contains a number of instructive photo-micrographs and other illustrations.

Fifty Years in Wall-street. By Henry Clews, LL.D. New York: Irving Publishing Company.

Dr. Henry Clews has had half a century's experience of American finance, and in this portly volume of over a thousand pages he gives an account of some of the most important men and events that have come within his ken. No spot in the world is so full of financial sensation and romance as Wall-street; nowhere are such vast fortunes made and lost with such astonishing rapidity. Dr. Clews had been in close touch with the heroes of these romances, and there are few New York financiers about whom he has not something to tell. He gives an interesting account of Daniel Dowe and his great fight with Vanderbilt; of George Peabody and his philanthropic schemes; of Johns Hopkins and his peculiarities; of Jay Gould, the Jerome Brothers, Chauncey Depew, and others, living and dead, too numerous to mention.

The cardinal object of the book, as stated by the author, is "to give the general public a clearer insight into the reputed mystery and true inwardness of Wall-street affairs." It will, of course, be principally interesting to the bankers and brokers of Wall-street; but as the author has written "a plain, unvarnished tale, drawing his material from experience and the records of reliable narrators," it will, no doubt, appeal also to a wider field.

Washed by Four Seas. By H. C. Woods, F.R.G.S. London: T. Fisher Unwin. 7s. 6d. net.

In this volume Mr. H. C. Woods, formerly of the Grenadier Guards, relates in a simple and unpretentious style the impressions gathered during his travels in Smyrna, Constantinople, and the near East. He does not give a continuous narrative of his journeys, but conveys under certain selected headings the results of his observations during two extended tours afar from the beaten track.

The book (in the words of Sir Martin Conway, who contributes a short introduction) "makes no pretensions to being a learned and exhaustive dissertation on any international problem. It claims merely to be the honest record of what fell under the eyes of an industrious and careful young traveller, who had a purpose in view in his wanderings, and was able to obtain information on certain important military and other questions not before acquired by any English expert."

To those who have not been over the ground described by the author, and who wish to obtain the kind of impression that would be produced on an intelligent traveller visiting it for the first time, the book will prove of great interest. The impressions of the people and their ways of life, of the dogs of Constantinople and their extraordinarily complicated *régime*, the descriptions of the scenery from the Golden Horn to the Rhodope Balkans and Bulgaria are clear and vivid, and are well illustrated by over sixty photographs taken by the author.

India and the Empire: a Consideration of the Tariff Problem. By M. de P. Webb, C.I.E., with an Introduction by Sir Edward FG. Law, K.C.M.G., K.C.S.I. London: Longmans. 3s. 6d. net.

Mr. Webb's book is mainly devoted to the consideration of the bearing of the Tariff Problem upon the trade and prosperity of India. His main object is described as two-fold, (1) "briefly to present the case for Tariff Reform and Preferential Trade in a somewhat new garb, and (2) more particularly to exhibit the true position and strength of India and the importance of her assuming a leading part in the rising movement for Imperial Tariff revision." This is a subject of too political a character for discussion in these pages, but a brief statement of the author's treatment of the subject may be set down here. Mr. Webb is chairman of the Karachi Chamber of Commerce and has on three occasions represented Karachi at Conferences of Chambers of Commerce in London, Montreal, and Calcutta. He draws attention to the action of the Indian Government in 1903, when it was urged that "whatever be the final decision of the Home Government in the matter, India might not be pledged in advance to accord equal treatment to imports from all countries alike, irrespective of the treatment meted out by such countries to India's exports."

The late Sir Edward Law, Finance Minister of the Government of India, in his Introduction to this book commends Mr. Webb's treatment of the economic problem, and describes his statement that, "where demand, labour, material, and capital are found in the greatest abundance, of the best qualities, and at the cheapest cost, the trade will develop at the greatest speed," as novel and interesting. Sir Edward praises Mr. Webb's fairness in statement, and says that he "faces the facts of the case very fairly, whether favourable to his general argument, or otherwise." Two main points which the author attempts to prove, are—(1) that the principles of Free Trade so successful in England during the second half of the last century, are not of universal application, and that India, with her 200,000,000 primitive agriculturists, would not benefit in the same way as a small population of highly skilled manufacturers dependent upon the outside world for raw material, and upon the sale of the finished products in the markets of the world. (2) The need of some means of Retaliation. This second point is illustrated by the suggestion of an export duty on jute, Bengal's chief product. Respecting Retaliation, Sir Edward Law writes, "In Russia, tariff regulations give a preference to Chinese over Indian tea. India is an important market for Russian petroleum. If Russia were threatened with an Indian customs tariff, discriminating against her petroleum, she would find it to her advantage to accord greater freedom of trade to Indian tea." Mr. Webb gives a series of quotations at the heads of his general chapter, and before his first chapter, he quotes Cobden to the effect that it is "the part of a wide community to alter the maxims by which its foreign relations have, in past times, been regulated in conformity with the changes that have taken place over the entire globe."

GENERAL NOTES.

Public Works in the Philippine Islands.—The American occupation of the Philippine Islands has not been followed by that rapid development of the resources of the country which many expected, but in the way of public works some progress has been made. This remark applies particularly to Manila harbour. The breakwater on the eastern side of the harbour has been extended, the entrance to the Pasig river and the harbour well dredged, strong walls constructed on the banks of the river as far as the first bridge, and two large steel and concrete wharves, one 600 feet by 70 feet, and the other 650 feet by 110 feet, with covering sheds, have been recently constructed. Referring to these works, Mr. Acting Consul-General Horne says (No. 4171, Annual Series) that the extension of the east breakwater has added much to the safety of the harbour, but there still remains a gap of 600 feet between the two breakwaters, which exposes a considerable section to the full force of the gales which prevail during the south-west monsoon. There is constant agitation in shipping circles for the closing of the gap, but as yet no definite action has been determined upon. A new water system for the city of Manila is under construction, and should be completed by July, 1909. It includes a gravity water supply, consisting of a masonry dam and inlet chamber, a steel pipe line about 10½ miles long, a masonry conduit in a tunnel, and an open cut about 4½ miles long, a receiving and distributing reservoir, &c., the cost being over £200,000. Railways are being built, the lack of transportation facilities having been one of the greatest hindrances to expansion in the mining and agricultural industries, and the necessity for railway development has been emphasised by the loss of a large proportion of the draught animals of the islands. In 1906 the Manila Railroad Company entered into an agreement with the Government to construct 428 miles of railroad throughout the Island of Luzon by the year 1913. At the date of the Consul-General's report 106·8 of the 428 miles were opened to traffic, and the surveys for the whole length had been completed. At the same time the Philippine Railway Company entered into an agreement to build 295 miles of railroads in the Islands of Panay, Negros, and Cebu by the year 1910. It is probable that an extension of time will be required for the completion of this work.

MEETINGS OF THE SOCIETY.

Juvenile Lectures.

Charles Waldstein, Litt.D., Ph.D., Slade Professor of Fine Art in the University of Cambridge, "Digging for Ancient Art Treasures." Two Lectures.

Lecture I.—January 6.—The excitement of the treasure-hunter—Uncertainty and mystery—Excavating combines all the elements of sport and excitement with higher and nobler spiritual aims—How ancient sites came to be buried—What the excavator might find in London two thousand years hence—Methods of excavating—Examples of prehistoric and Egyptian digging—The only records of prehistoric man out of which our knowledge concerning him is derived—Excavations of ancient Troy, Mycenae, Tiryns—Dr. Evans's work in Crete—Minos and the Cretan Labyrinth.

Lecture II.—January 13.—Some of the lecturer's excavations—The tomb of Aristotle and its contents—The Argive Heraeum—Plataea—The great excavations of the Germans at Olympia and Pergamon—The French at Delphi—Specimens of beautiful works of Greek Art which the spade has restored to us—The future of excavation—Herculaneum.

The lectures will be fully illustrated by lantern slides taken during the excavations, and from the works of art recovered.

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FRIDAY, JANUARY 1, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, JANUARY 6th, 5 p.m. (Juvenile Lecture.) CHARLES WALDSTEIN, Litt.D., Ph.D., Slade Professor of Fine Art in the University of Cambridge, "Digging for Ancient Art Treasures." (Lecture I.)

[Most of the tickets have now been issued, but there still remain a few, which will be supplied to members who apply for them at once.]

Further particulars of the Society's meetings will be found at the end of this number.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

TWENTY YEARS' PROGRESS IN EXPLOSIVES.*

By OSCAR GUTTMANN, M.Inst.C.E., F.I.C., F.C.S.

Lecture II.—Delivered November 30, 1908.

I mentioned in my previous lecture that Sobrero invented nitroglycerine in 1847. It is known that, although he recognised the value of this invention for civil and military blasting purposes, practically no use was made of it until 1867, when Alfred Nobel invented dynamite, and was not deterred, by accidents and prejudice, from introducing it into the service of mankind. You know that before this time, Mowbray, in Massachusetts, manufactured nitroglycerine, and carried it into the mines in the frozen state.

Nobel devised processes for the manufacture of nitroglycerine on a large scale, and the machinery for it was constructed to his ideas by his life-long adjutant, Mr. Alarik Liedbeck, of Stockholm. Since there is a full description of all the apparatus in use in my book on "The Manufacture of Explosives," which appeared in 1895, I can confine myself to dealing with the progress made since that date. You will find described in that book two kinds of apparatus for nitrating glycerine, those that have a helical revolving stirrer for mixing purposes, and those that are agitated by compressed air. Occasionally both mechanical and compressed air stirring are used. One has learnt in time to control the operation of nitration more efficiently, and this inspired confidence to increase the size of the apparatus. I believe the largest apparatus made in lead nitrates 680 kilogrammes of glycerine at one operation, whilst, in America and South Africa, steel apparatus, with mechanical stirring gear, are mostly used, some nitrating 1,000 kilogrammes at a time. In one United States works, they have gone so far as to have four such steel nitrators, each for a charge of 1,000 pounds of glycerine, in one room, and driven from one main shaft, but present practice is to have two such nitrators in one building. In this country one would not allow more than one nitrating apparatus to be used at a time. Of course, each nitrator is provided with a series of lead or steel coils through which cold water circulates, and it has now become frequent to install a refrigerating plant, and to circulate water of only 10°C. and less through the coils.

Twenty years ago the recovery of glycerine from soap lyes had just begun, most of the glycerine used being so-called "refined," which was a fairly pure material, coloured dark by cell substances that had been

slightly burnt in the stills. Now-a-days, practically all glycerine used is "distillation," recovered by neutralising the soap lyes and distilling off the glycerine contained therein. It is almost chemically pure, and a substance of reliable uniformity.

With regard to the composition of the nitrating mixture, it has been customary in well-conducted factories during the last 20 years or so to nitrate 110 kilogrammes of glycerine in a mixture of 300 kilogrammes of nitric acid, of about 93 to 94 per cent. monohydrate, and 500 kilogrammes of sulphuric acid of 96 per cent. monohydrate (and not, as Sir Frederic Nathan and Mr. Rintoul stated, 100 parts of glycerine and nitric acid of 91 per cent. only).* This corresponds to about 255 parts of nitric acid monohydrate and 436·4 parts of sulphuric acid monohydrate, or a total of 691·4 parts of acid monohydrate with 35·8 parts of H_2O (4·9 per cent.) to each 100 parts of glycerine.

Some sixteen years ago, Messrs. Chapman, Messel, and Co., and the Badische Anilin und Sodafabrik tried to introduce sulphuric acid anhydride for the manufacture of explosives. At that time the price of anhydride was still such as to preclude its use for strengthening up the waste sulphuric acid of about 1·600 sp. gr. obtained in denitrating waste acids, and it was also considered impractical to add it to the waste acid itself. About eight years ago, however, in France and elsewhere, mixtures of nitric and sulphuric acids of high strength, obtained by the addition of sulphuric anhydride, were used for nitrating glycerine, and as soon as the processes for manufacturing sulphuric anhydride were no longer kept secret, but became known through the patents which were at last applied for, a number of explosives factories erected such works. It is now customary to add sulphuric acid containing 20 per cent. of anhydride (oleum) to the original mixture, but it is still found impracticable to add it to the waste acid. It will be seen from the paper of Sir Frederic Nathan and Mr. Rintoul, on "Nitroglycerine and its Manufacture," that the use of anhydride has reduced the quantity of sulphuric acid required. Five years ago already I found in the Pozsony factory of Nobels the use of mixed acid consisting of 37·2 per cent. HNO_3, 60 per cent. H_2SO_4, and 2·8 per cent. H_2O, and made with anhydride. Although no artificial refrigeration was used, the yield of nitroglycerine amounted to 220 for 100 glycerine and a ratio of 6·318 of acid to 1 of glycerine. Factories using Nathan, Thomson, and Rintoul's process now employ a mixture of 41 per cent. HNO_3, 57·5 per cent. H_2SO_4, and 1·5 per cent. H_2O, corresponding to 250 lbs. HNO_3, 350 lbs. H_2SO_4, and 9 lbs. H_2O for each 100 lbs. of glycerine, which gives a ratio of 6·09 of acid to one of glycerine, as against 6·91 to 1 formerly required. It is thus seen that this process requires about the same quantity of nitric acid per 100 glycerine as the old process, but about 86 pounds, or roughly 20 per cent. less sulphuric acid. It will, therefore, simply depend upon the price of the sulphuric anhydride whether it is advantageous to use it.

With the present prices of £3 per ton of 96 per cent. sulphuric acid, and £3 15s. per ton of sulphuric monohydrate containing 20 per cent. of anhydride, the difference between the cost of materials with the former yield of 220 and the present one of 229 nitroglycerine is shewn in the following calculation :—

OLD PROCESS.

	£	s.	d.
1·10 tons of glycerine at £50 ..	55	0	0
3·00 „ 93·5 per cent. nitric acid at £20	60	0	0
5·00 „ 96 per cent. sulphuric acid at £3	15	0	0
Yield 2·42 tons of nitroglycerine	130	0	0
Cost per ton........	53	14	5

NEW PROCESS.

	£	s.	d.
1·00 ton of glycerine at £50	50	0	0
2⅝ „ 91 per cent. nitric acid at £19 10s.	53	12	6
3⅓ „ H_2SO_4 with 20 per cent. SO_3 at £3 15s.	12	10	0
Yield 2·29 tons of nitroglycerine	116	2	6
Cost per ton	50	14	3
Difference per ton	3	0	2

Or approximately 5·6 per cent.

It would, therefore, seem that the price of anhydride ought to be lowered, which should not be difficult, considering that the makers actually dilute the anhydride in order to make acid of 100 per cent. strength.

In making this comparison it must be remembered that, with the new process, the

* "Journal of the Society of Chemical Industry," 16th March, 1908. Compare also Guttmann, "Manufacture of Explosives," Vol. II., p. 63.

same apparatus will hold 18 per cent. larger charges.

After nitration the mixture is allowed to stand, when the nitroglycerine separates from the waste acid and floats on the top. This operation is usually performed by running the nitrating mixture into a separate vessel, having a conical or inclined bottom, the so-called separator, from which the nitroglycerine is taken off either by means of a skimmer or by earthenware cocks placed at about the level where nitroglycerine and waste acid meet. The separation of nitroglycerine from the waste acids is sometimes considerably delayed by the formation of a silicious colloid, which agglomerates with particles of cell substance and other impurities, forming fern-like growths. The Dynamit Actien Gesellschaft in Hamburg* found a very efficient means of promoting separation in the addition of high boiling paraffin in quantities of 0·5 to 2 per cent. of the weight of glycerine, whilst Dr. L. F. Reese, of Wilmington†, adds as little sodium fluoride as 0·002 per cent. (1 in 50,000) of the glycerine employed to the nitrating mixture with excellent results. Both methods are now used in very large factories. For more than 30 years some factories had been in the habit of employing one vessel only for both nitrating and separating, and withdrew the nitroglycerine from three earthenware cocks, placed at short intervals at the separating line. This enabled them to gain considerably in levels, and to carry out the manufacture, right up to the final washing, on practically the same level.

The waste acid was always sent to after-separation houses, which were frequently called by the German name of "Nachscheidung." They were designed by Mr. C. Goepner, in 1882. The acids were kept therein in large lead vats, having a dome-shaped cover carrying a glass tube, fitted with a cock or stopper at the side. Cooling worms kept the temperature down, and the nitroglycerine which separated out was displaced by adding some waste acid from a tank on a higher level until the nitroglycerine rose in the glass tube, and could be withdrawn through the cock or tubulure. Since the waste acid sometimes had to be kept in these after-separation houses for a week, in order to get rid of all the drops of nitroglycerine, which separated out, decomposition occasionally set in. A very small number of factories, therefore, adopted the plan of placing the waste acid in a lead tank, standing apart from other buildings, and tipping into it water from a small tank, pivoted in a suitable manner. The heat, generated by the sudden addition of water, decomposed the waste acid, and the nitric acid was driven off. Whilst this was certainly an efficient, if somewhat risky, method of decomposing all the nitroglycerine contained in the waste acid, it was also wasteful in causing the loss of all the nitric acid. A better plan was thereupon introduced in France, and elsewhere, which consisted in gradually diluting the waste acid by the addition of from 2 to 3 per cent. of water, thereby stopping the further formation and separation of nitroglycerine.

At the Government Factory at Waltham Abbey these methods have been improved upon. A so-called nitrator-separator is used, in which the nitroglycerine has time to separate from the acids, and waste acid is then added from below, thereby bringing the level of the nitroglycerine to a point where it will run out through a gutter into the preliminary washing tank. In this way the use of cocks is avoided. When all the nitroglycerine has been displaced, about 2 per cent. of water is introduced gradually to avoid undue heating of the mixture, further formation and separation of nitroglycerine thus being prevented. Sir Frederic Nathan and Mr. W. Rintoul describe in their above-mentioned paper how they investigated the conditions under which nitroglycerine was absorbed by the waste acids.

The result of this combination of a number of useful processes, namely, the employment of anhydrous sulphuric acid to produce a mixed acid containing little water, the use of refrigerated water to cool the acids, the displacement of the nitroglycerine by means of waste acids, which obviated the remixing of acid and nitroglycerine on emptying the nitrator, and the addition of water to stop the separation of further quantities of nitroglycerine, was that they together contributed to yield much better results. As a matter of fact, in well-conducted works, the yield of nitroglycerine with the proportion of 6·91 to 1 mentioned above was between 217 and 220; at Waltham Abbey it was possible to obtain by the "displacement process" a yield of 229 parts nitroglycerine for 100 parts, instead of the former 220 parts. According to Mr. de Mosenthal the Nobel works obtained similar good results. This yield has to the author's knowledge been

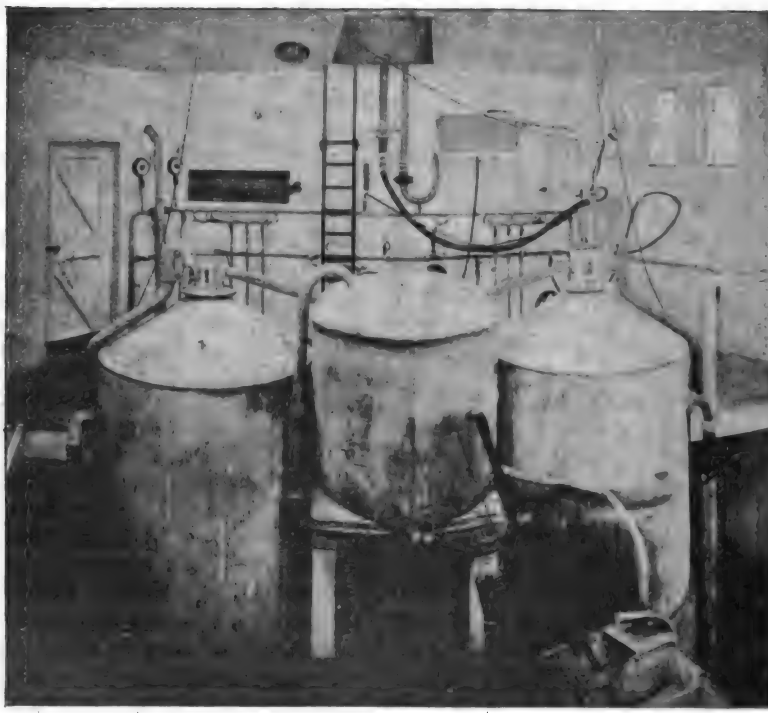
* British Patent, No. 13562, of 1904.

† British Patent, No. 20310, of 1905.

only once exceeded in a Belgian factory, when a charge of nitroglycerine had to be drowned on a cold winter's day. The contents of the tank froze and required two days to thaw; a yield of 240 nitroglycerine was, however, the surprising result. It is a fact, also, that by this process the nitration, first separation and first washing, can all be done on the same level, whilst no after-separation house and apparatus are required. The drawback of the system is that the number of apparatus required is no smaller than before, because, whilst one nitrator-separator is at work, no other apparatus may be used in the same building, and the separation takes a good deal more time than before on account of the several manipulations required. With the nitrator-separator apparatus formerly in use, where the nitroglycerine is drawn off through cocks, about 30 inches more head are required for the whole system. Certain other works were able to reduce further the difference of level by drawing up the prewashed nitroglycerine into a final washing tank by means of a previously evacuated vessel. The author has constructed one of these in such a way, that no cock whatever was necessary except for the vacuum pump.

With regard to the selection of apparatus, round lead or steel tanks, as explained above, are generally used, but the author has also seen square-cornered ones which seem to present some advantage, their oblong form making it easier to arrange the coils in them, while both the entrance of glycerine and that of compressed air can be arranged for in several places; better mixture is secured thereby. The Americans are much in favour of mechanical stirring, while in Europe air-stirring is preferred. Having worked with both, I cannot see much difference as regards results, but since I do not like to have any moving parts in connection with the manufacture of nitroglycerine, I think air-stirring is preferable on the whole.

FIG. 1.



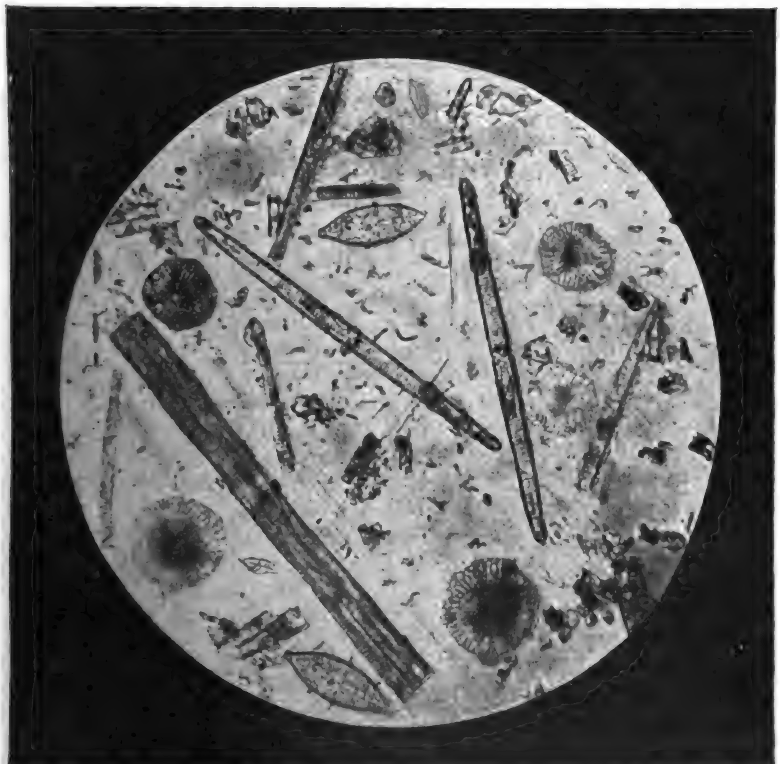
NITRATOR-SEPARATOR. (Nathan, Thomson, and Rintoul's Patent.)

There has been no special improvement in the manufacture of dynamite since Nobel, in 1875, invented blasting gelatine. This and the gelatine dynamites, made by mixing a thin blasting gelatine with an absorbing powder of potassium nitrate and wood meal, have in most countries driven Kieselguhr dynamite out

of the field. As a matter of fact, only a few tons of such dynamite are sold in either Germany and Austria, but a certain quantity is still produced in this country.

In this connection it will be interesting to have a true picture of Kieselguhr as used for dynamite. Mr. Henry de Mosenthal, whose skill in preparing specimens for the microscope we have often had occasion to admire, has prepared for me various slides of kieselguhr, which has undergone the usual calcining process in manufacture, and which I selected on account of its high absorbing capacity (80 to 82 per cent. of nitroglycerine). A good deal of care was required in photographing this specimen, as a number of characteristic diatoms had to be cut out and combined into a new photograph, but I think the result was well worth the trouble.

FIG. 2.



CALCINED KIESELGUHR.

For blasting gelatine, as you know, a so-called collodion cotton or soluble nitrocellulose is employed. On account of the very stringent regulations in this country, and more especially in Australia and South Africa, it is necessary to use a special collodion cotton, which will not only be completely soluble in nitroglycerine, but will sufficiently retain it under any climatic conditions. The selection of such collodion cotton is not an easy matter, and it will generally be found that an inferior nitrocellulose will not produce a good gelatine, however much of it is put in. Many people think that if 7 per cent. of nitrocellulose are insufficient to make a stiff and suitable blasting gelatine, the addition of another 1 or 2 per cent. will do it, and certainly at first the resulting gelatine is so stiff and hard as to require special effort in the cartridge machines. After a few months of storage, however, or after passing the equator across to Australia, nitroglycerine is found to exude. A good nitrocellulose will give a perfectly stiff blasting gelatine with between 6 and 7 per cent. of nitrocotton, and if a 2½ per cent. solution is

made in a porcelain basin, the resulting gelatine should be easily detachable after cooling, showing no signs of exudation.

If no improvements have been made with regard to increasing the strength or altering the composition of dynamite to obtain better results, there has been within recent years a revival of old ideas, but with better success, for the purpose of obviating one of the chief objections to dynamite, namely, that of freezing. It was in 1866, in Sweden, that A. E. Rudberg patented the addition of nitrobenzene to nitroglycerine, for the purpose of making it unfreezable.* This patent being in a language hardly understood elsewhere, and at that time no printed specification having been published in Sweden, the invention was so forgotten, that Nobel, a Swede himself, patented it again in 1886.† I had myself worked on the same subject in conjunction with Nobel, but I found that most additions to nitroglycerine reduced the explosive power considerably, when used in such quantities as to be efficient. The Société des Poudres et Dynamites, of Arendonck, found later,‡ that the addition of dinitrotoluene dissolved in nitroglycerine was very useful in lowering the freezing point. A new departure was really made, when Dr. Anton Mikolajczak, in 1904, patented the addition of dinitroglycerine to trinitroglycerine explosives, and at the same time indicated a practical method of manufacturing it.§ It is now made on a large scale in a factory at Castrop, in Germany. Liecke mentioned already, in 1865, that he obtained mono- and dinitroglycerine by nitrating pure glycerine at 0·° in a mixture of 1 volume of nitric acid of 1·4 specific gravity and 2 volumes of concentrated sulphuric acid.‖ In the German patent, No. 58957, of 1890, Wohl described some properties of mono- and dinitroglycerine, and mentioned their suitability for reducing the freezing point of nitroglycerine. In order to understand the question better it is necessary to point to a most interesting work by Sigurd Nauckhoff¶ showing why nitroglycerine can sometimes be subjected to intense cooling without freezing (super cooling), and to a paper by Dr. H. Kast** showing that there are two kinds of nitroglycerine (one being an allotropic modification) with two different melting points, one nitroglycerine solidifying at about 13·2°, and the other at about 2·1°, the melting points being 13·5° and 2·5° respectively.

* Swedish Patent, April 30th, 1866.
† British Patent, No. 5330, of 1886.
‡ British Patent, No. 14827, of 1903.
§ British Patent, No. 8041, of 1904.
‖ Mittheilungen des Hannoveranischen Gewerbe Vereines, 1865, p. 214.
¶ Zeitschrift für Angewandte Chemie, 1905, p. 11.
** Zeitschrift f. d. ges. Schiess u. Sprengstoffwesen, 1906, p. 225.

Professor Will, in an investigation on glycerine nitrates,* has given a historical *résumé* of the invention of dinitroglycerine, and made extensive experiments on the use of mono- and dinitroglycerine. Without going closely into the matter, which is best studied in Will's original paper, the conclusion at which he arrives may be mentioned, namely, that dinitroglycerine is not a sure guarantee against solidification, and that under certain conditions, explosives prepared with it may become solid at a higher temperature than trinitroglycerine explosives.

Since dinitroglycerine is somewhat hygroscopic, and its manufacture more expensive than that of trinitroglycerine, a number of other inventors have tried to find suitable substitutes for the prevention of solidification. In the first instance, the substitution of a hydroxyl group in the glycerine by hydrochloric acid was tried, monochlorhydrine being obtained. From this the Westfälisch-Anhaltische Sprengstoff - Gesellschaft made dinitromonochlorhydrine and mononitrodichlorhydrine.† On the other hand, glycerine is polymerised by heating it with concentrated sulphuric acid, whereby diglycerine is obtained. This can also be obtained by the prolonged heating of glycerine without acid to between 290° and 295°. If some diglycerine is added to ordinary glycerine and the two nitrated together, a mixture of trinitroglycerine and dinitro- or tetranitrodiglycerine is obtained, which prevents freezing.‡ The Deutsche Sprengstoff Gesellschaft has patented monochlordinitroglycerine,§ whilst Escales (Lehmann) prepares a complex product of various chlorhydrines and diglycerines, and nitrates the mixture.‖ Another addition was proposed by Vender, who prepared dinitroacetine and dinitroformine.¶

Of all these additions none has so far been definitely adopted for the manufacture of unfreezable dynamites, but I believe that lately dinitrodichlorhydrine has been used with considerable success by the German works of the Nobel companies.

* Berichte der Deutschen Chemischen Gesellschaft, 1908, p. 1107.
† British Patent, No. 4057, of 1906.
‡ British Patent, No. 6314, of 1906.
§ British Patent, No. 14958, of 1905.
‖ British Patent No. 21117, of 1907.
¶ British Patent, No. 9791, of 1906.

With regard to safety explosives containing nitroglycerine, I shall have more to say when speaking about safety explosives in general.

We now come to gun-cotton. The history of the invention of gun-cotton has been told so often, and the steps that led up to its successful manufacture during the last forty years have been so often detailed, that I need not refer to them at any length. The really important step in the manufacture of gun-cotton was taken when the British Government adopted a process of pulping and purifying the gun-cotton, first patented by John Tonkin, jun., of Poole, near Copperhouse in Cornwall,* and again, in combination with the compression of the pulped gun-cotton three years later, by Sir Frederick Abel.† The next step was made when the principle of the detonation of nitro-compounds by means of a small fulminate of mercury charge, invented by Alfred Nobel,‡ was extended by Mr. Brown, Sir Frederick Abel's assistant, to gun-cotton.§

The British Government gave the German Government an opportunity of inspecting the gun-cotton works at Waltham Abbey, and supplied them with plans for the erection of a similar factory, which is still in existence in Kruppamuehle in Upper Silesia.

Baron von Lenck, the Austrian General who worked most assiduously as the pioneer of Schönbein's invention, used gun-cotton in hanks; the British Government introduced the use of cotton waste from spinning and other operations where threads are made. The reason for this change is not quite apparent, unless it was felt, that since the cotton had to be pulped in any case the cheaper waste might do just as well as the long threads. This use of cotton waste has continued ever since. Originally it was boiled in a 2 per cent. sodium carbonate solution only, and then carefully washed; later on caustic soda was used; and with the advent of smokeless powders very stringent regulations were drawn up as to the amount of fat permissible in the cotton, and great importance attached to the cotton being white and clean. As a result large cotton bleaching works have been established in which the cotton is boiled with caustic soda for the removal of fat, then bleached with bleaching powder, and after washing neutralised with sulphuric or hydrochloric acid, the calcium sulphate or chloride formed being carefully washed out again. Other works bleached with calcium sulphide or similar strong bleaching agents. The cotton so treated is dried, and either sold in this state or else passed through a willow or similar carding machine. In the latter case it has been freed from nails, wire, and other accidental admixtures, which are generally found in cotton bales. For insoluble gun-cotton, as used in torpedoes, shell charges, &c., uncarded cotton waste is bought in this and several other countries, whilst for collodion cotton carded and very white cotton is generally preferred.

* British Patent, No. 320, of 1862.
† British Patent, No. 1102, of 1865.
‡ British Patent, No. 1345, of 1867.
§ British Patent, No. 3115, of 1868.

It is very curious that in the purchase and use of nitric and sulphuric acid for the nitration of gun-cotton, most stringent conditions are laid down with regard to freedom from mineral matter, chlorine, sulphates, arsenic, &c. Yet, as far as I could ascertain, no special precautions seem to be taken in the case of cotton to guard against impurities. The conditions of supply in this country simply demand a certain small maximum of fat, and reliance is placed upon practical tests. In other countries they even go so far as to ask for the cotton to be white and free from iron parts. As a matter of fact, uncarded cotton waste, as used for gun-cotton, generally contains a quantity of strings, wicks, coloured threads, india-rubber or elastic cords, and similar leavings, showing the origin of the waste; and no amount of hand-picking can free the cotton absolutely from such impurities. I have further found in cotton supplied by manufacturers of the best repute a large amount of chlorine, sulphate of lime, and sulphides, besides organic and mineral dust, which gave the cotton quite a grey appearance.

Is it not also strange that it never occurred to anybody—at least as far as I know—to ascertain whether the impurities in the cotton brought about by forcible treatment with bleaching agents and acids, are responsible for a great deal of the instability of certain finished gun-cotton and smokeless powders? I am convinced that this is the case. It is true that Cross, Bevan and Jenks,* as well as Lunge and Bebie,† have compared the nitration of raw cotton with that of bleached cotton, but only as far as yield, solubility, and combined sulphuric acid are concerned; nobody, however, seems to have given it a thought that such a complex compound as cellulose in the shape of cotton must vary to an enormous ex-

* "Journal of the Society of Chemical Industry," 1900, p. 318,
† "Zeitschrift für angewandte Chemie," 1901, p. 483.

tent, both in its physical and its chemical structure, and thereby also the nitrocellulose made from it, thus requiring far more control than the mere percentage of nitrogen and the solubility and viscosity may involve.

Let us examine the possible changes. In the first instance we have the cotton itself, which may be in any stages of ripeness. It is well known, that the riper the cotton the better the fibre and the more easily it takes dyes, so much so that there is what is known as dead cotton, which causes spots in dyed fabrics. It has frequently been examined under the microscope, but quite recently Dr. R. Haller* has investigated this dead cotton by means of ammoniacal copper solution, caustic soda, &c. Such cotton is, according to T. H. Bowman,† always insufficient in strength and breaks up in the manufacturing process. Haller found that it dissolves with difficulty in ammoniacal copper solution, is only coloured slightly yellow by iodine-potassium-iodide solution, and shows no brilliancy in polarised light. Only fully matured cellulose gives normal reactions.

The investigations of Leo Vignon‡ on the formation of oxycelluloses and hydrocelluloses and the behaviour of their nitro-compounds, show plainly how cotton and cotton waste may, by the nature of the treatment they undergo, be partly transformed into oxycellulose, which gives an unstable nitro-compound, and into hydrocellulose, which has a different rate of nitration to ordinary cellulose.

I have repeatedly stated on previous occasions that, in my opinion, the process of nitration with a mixture of sulphuric and nitric acid results in the first instance in an attack on the cotton by the sulphuric acid similar to that in the manufacture of vegetable parchment, and that the sulphuric acid is gradually displaced by the nitric acid penetrating the fibre. It is obvious that, according to the quantity and the strength of the sulphuric acid present in the mixture, nitration will proceed more or less rapidly and thoroughly, and that consequently the nature and the character of the nitrocellulose may be thoroughly altered according to the proportion and strength of acids used. Lunge and his collaborators have shown this influence as far as it can be shown in nitrating small quantities of medicinal cotton, which is not suitable for nitration on a large scale.

It seems a fact that the more oxycellulose is formed in the cotton before nitration the more unstable are the compounds formed in the nitrocellulose. Other impurities in the cotton are all the more likely to endanger the stability of nitrocellulose, as their nature is always unknown and varies from sweepings to india-rubber elastics; while almost all are sure to produce unstable compounds.

How far the nature and origin of the acids may have an influence upon the ultimate product has still to be investigated. It is by no means impossible that the system of revivifying waste acids by means of sulphuric anhydride, which is now much in vogue, may, from the nature of the process of the latter's manufacture, introduce certain risks, more especially as it always contains some sulphurous acid. It is also known from the investigations of Will that the waste acid from the manufacture of gun-cotton generally contains nitro-compounds of various sugars, some of which are highly unstable; and it was found in Waltham Abbey that the use for the manufacture of nitroglycerine of nitric acid, made with waste acids from gun-cotton manufacture, was impairing the stability of the nitroglycerine. It is therefore quite conceivable that the origin of the nitric acid may have an important bearing upon the stability of nitrocellulose, although it is said that nitric acid made with gun-cotton waste acid does not affect the nitrocellulose made therewith in an adverse manner.

I do not think that differences in apparatus used for the manufacture of nitrocellulose have much to do with its stability. There certainly is a difference in the amount of ash according to whether an iron, lead, or earthenware apparatus has been used, and it is quite conceivable that the solubility and viscosity may be influenced by the method of dipping and nitrating. To what extent the presence of iron salts formed in iron apparatus affect the stability is still a problem worth investigation. I have strong reasons for not recommending iron vessels for stabilisation in the first instance. Considering all that I said above, I believe that if one must use nitrocellulose, and if, as seems to be the case, cotton is the best material for making it, one ought to use the natural cotton only, and not common yarn, and less still waste, which have both undergone so much forcible, mechanical and chemical treatment as to alter completely the character of the cellulose, and introduce elements of uncertainty and danger. These should be avoided by the use of ripe, raw

* "Chemiker Zeitung," 1908, p. 838.

† "The Structure of the Cotton Fibre," London, 1908, p. 114.

‡ "Comptes Rendus," 6th June, 1898; 10th and 17th September, 1900.

cotton, which, of course, would have to undergo suitable treatment to eliminate fat, husks, and other impurities, but would not necessitate the whole bleaching operation with its attending defects.

The selection of the raw cotton is so far carried out purely on practical lines by nitrating various samples. Besides cotton, blotting paper made from cotton and paper shreds were recommended, also tissue paper, cellulose as used for paper making, rags and other raw materials. All the cotton substitutes were however discarded, and even the celluloid and artificial silk industries use cotton. Soda cellulose is taken for Schultze powder and some nitrocelluloses of minor importance.

The cotton is generally hand-picked and opened in a willow, the better varieties of which are provided with a fan to draw off the fine dust formed. It is then dried to about 0·5 per cent. of moisture. Some factories use a drying machine.

Formerly the mixture for gun-cotton consisted of 1 part of 1·500 nitric acid and 3 parts of 1·840 sulphuric acid, and each charge was revivified by taking away one quarter of the waste acid, and adding a mixture rich in nitric acid, so as to obtain about the original composition. The following table shows the result of revivifying the waste acid ten times in a series of operations made in 1886 by Dr. Abelli and the author :—

No.	Composition of nitrating mixture. Proportion 1:40.			Temperature of nitration.	Yield %.	N. %.	Soluble %.	Composition of waste acid.		
	H_2SO_4.	HNO_3	H_2O.	Deg.				H_2SO_4.	HNO_3.	H_2O.
1	72·82	24·37	2·81	20	146·25	13·32	3·60	75·15	19·00	5·85
2	71·82	23·00	5·18	10	167·50	13·34	2·10	76·00	18·40	5·60
3	72·45	22·52	5·03	14	169·00	13·39	7·20	73·40	19·10	7·73
4	70·21	23·05	6·74	10	165·75	13·49	2·93	71·40	20·22	8·38
5	68·77	25·97	7·26	12	175·00	13·38	2·88	71·06	20·51	8·43
6	69·47	23·40	7·32	10	166·25	13·08	2·26	71·72	19·43	8·85
7	70·00	22·34	7·66	10	165·00	13·40	4·00	71·71	18·82	9·47
8	70·00	21·85	8·85	9	152·50	13·30	4·80	70·70	19·35	9·95
9	69·18	22·58	8·24	6	167·50	13·22	1·60	71·00	19·13	9·87
10	69·40	22·00	8·60	9	152·50	13·21	3·46	70·00	19·00	11·00

The original mixture consisted of 1 part of nitric acid to 3 parts of sulphuric acid, both of over 97 per cent. monohydrate. Three parts of waste acid were revivified with one part of fresh acids.

It will be seen that the percentage of nitrogen contained in the nitrocellulose reaches a maximum when the percentage of water in the acid mixture is about 9 per cent, and not, as might be supposed, in the stronger acid. This observation led several factories to study the influence of water on the amount of nitrogen in and the solubility of the nitrocellulose, and it was found that thereby it was possible to secure uniform and predetermined results. Lunge and his pupils have made this and various other influencing factors the object of extensive investigations, and their results are a most valuable guide to manufacturers, although they cannot be translated directly into practice.

The majority of factories prepare the nitrating mixture by giving special consideration to the percentage of water in the first instance, because, by varying this, nitrocelluloses of widely different properties can be obtained. I have often said that, by varying the concentration of the acids, their temperature and the time of nitration, one has three factors, each of which can to a certain extent influence every property of the nitrocellulose obtained. Lunge and his pupils have shown by their researches what law obtains for every step in the alteration of each of these factors. To quote only a few instances. By varying the percentage of water and the ratio between nitric and sulphuric acid, Sir Henry Roscoe showed in the cordite case that he obtained a soluble and insoluble nitrocellulose, the one with 12·73 per cent., and the other with 12·83 per cent., or practically identical percentages of nitrogen. As shown in the previous table, an increase in the percentage of water up to a certain point rather tends to give the nitrocellulose a higher percentage of nitrogen, but without increasing the percentage of soluble nitrocellulose contained therein. If, however, the percentage of water exceeds 9 per cent., more and more soluble nitrocellulose is formed

until the transition into a wholly soluble nitrocellulose takes place fairly rapidly. It is the custom in the majority of factories to produce soluble nitrocellulose by taking equal parts of nitric acid of 75 per cent., monohydrate and sulphuric acid of 96 per cent. monohydrate and nitrating the cotton at a temperature of 40° C. This nitrating acid therefore contains 14·5 per cent. of water, yet by merely altering the proportions of acid it is quite possible to make very good soluble nitrocellulose in the cold, and some modern factories make it in this way. It seems to be very difficult, if not impossible, to obtain good and stable completely insoluble nitrocellulose from wood pulp.

It is now recognised on all sides that there are no definite stages of nitration in nitrocellulose, but that the change in composition goes on without a break, if the conditions are suitable. Thus, for instance, the treatment to which gun-cotton is subjected in the course of stabilisation has a great deal to do with its ultimate composition. Bruley* has already shown that prolonged boiling makes the gun-cotton more soluble, and also reduces the percentage of nitrogen. Excessive pulping also affects the solubility, whilst long treatment, with even such feeble alkalies as calcium carbonate, tends to hydrolise the nitrocellulose, and in any case decomposes oxycellulose. The manufacturer of gun-cotton and nitrocellulose is, as a matter of fact, face to face with great difficulties. Almost everything he does tends to act detrimentally. From the nitration, his nitrocellulose contains a number of lower nitro-compounds, nitrated oxy- and hydrocellulose, nitrosaccharoses, &c., which he has to get rid of. The usual way to do this is to boil the nitrocotton for a long time, and when, by the application of the well-known potassium iodide test, the nitrocotton is shown to be reasonably free from such admixed impurities, it undergoes further treatment by means of pulping. This is the process as carried out at Waltham Abbey, whilst in other factories the cotton undergoes a further treatment after pulping. It is not quite clear why one should keep on boiling the long and closed up fibres of unpulped gun-cotton for say 50 hours, as is done in some factories. One would imagine that if, after a preliminary working or boiling, the gun-cotton were pulped and then boiled, this could be done much more quickly. As a matter of fact, I have found that by heating the gun-cotton whilst pulping, the increase in stability is very much accelerated, and several factories use the method with advantage. In France they boil for 100 hours, and I have quite lately seen nitrocellulose that was boiled for 200 hours, without, however, being much the better for it. It must, however, be mentioned, that the Waltham Abbey gun-cotton as at present made, is a very stable and good gun-cotton as judged both by the iodide test and by the destructive test, of which more will be said later on. This is due in the first instance to an investigation carried out by Dr. Robertson. He showed that the former method of giving short boilings of two hours, and following them up with long boilings of eight and twelve hours, was erroneous, and that two long boilings of twelve hours each would liberate acid from the nitrocellulose, giving an acid water which hydrolyses all the impurities without attacking the gun-cotton itself, and that subsequent short washings are useful in eliminating the products of hydrolysis. Having had frequent occasions to put Dr. Robertson's principles to a practical test, I consider it to be one of the most useful pieces of work accomplished since the invention of gun-cotton.

The nitration of the gun-cotton had originally been performed in iron dipping pans, some fresh acid being added from time to time, and the dipped cotton, after squeezing out the bulk of the acid, left to complete the nitration in small earthenware pots. Later on, nitration in large pots or cast-iron pans holding up to eight or more kilogrammes of cotton was carried out with carefully prepared and analysed mixtures of acid, which were revivified by properly analysing the waste acid and adding the necessary revivifying acid. Messrs. Selwig and Lange, of Braunschweig, have, as is known, invented the so-called nitrating centrifugal machine, wherein the cotton is dipped and allowed to stand for the requisite time, and the nitration being complete, the centrifugal is set in motion and the acid wrung out. In other words, the removal of the nitrocotton and the nitrating acids from the nitrators into the centrifugal machine is avoided. Latterly, Messrs. Selwig and Lange have introduced a system in which the centrifugal machine is revolved at a slow speed during the nitration. The acid is thereby forced upwards through the hollow boss of the basket and comes out again in a number of small streams at the top, thus continually circulating. I am perhaps a heretic, but I

* "Mémorial des Poudres et Salpêtres," 1895-6, p. 131.

have never been able to see the great advantage of these nitrating centrifugal machines. They cost a great deal of money; they are liable to get out of order; one can only nitrate about eight kilogrammes of cotton in each, and with a nitrating period of say half an hour, one can at the best make ten charges a day in each; further, if the nitrating time is an hour, the number of nitrations is about seven only. This means that for a fairly large production one requires a large number of centrifugals, and it is easy to calculate what this would mean in an artificial silk factory producing say three tons of nitrocellulose per day. The quantity of acid used for nitration must be greater because the space between the basket containing the cotton and the jacket of the machine has to be filled up with acid, and similarly there are a good many other disadvantages. There is no difficulty in arranging pots or basins in such a way that the fumes arising from them are led away by means of an earthenware fan into an absorbing tower, just as is done in nitrating centrifugals, and discharging these nitrating vessels into a wringing machine without its being necessary to expose the workmen to fumes or spilt acid. Such factories are working since very many years, and give every satisfaction. In artificial silk factories where speed is of the greatest importance the acid is eliminated by putting the nitrated cotton into a lead basket and applying hydraulic pressure on a piston. At the same time such factories do not trouble much about the analysis and the exact conveyance of acids, but all the acid running out from the hydraulic press is conveyed in open cast-iron gutters into a large storage tank into which revivifying acid runs in continuously at a definite rate, thus keeping up the average of the acid throughout the day. I know of a factory where for the last six years the acid has never been renewed, but only revivified in this way.

FIG. 3.

NITRATING CENTRIFUGALS.

Since there is an excess of waste acid produced in revivification, this waste acid is

sometimes denitrated in the same way as the acid from nitroglycerine manufacture; but may more advantageously be used in manufacturing fresh nitric acid, because in this case the nitric acid contained in the waste acid is recovered as pure monohydrate.

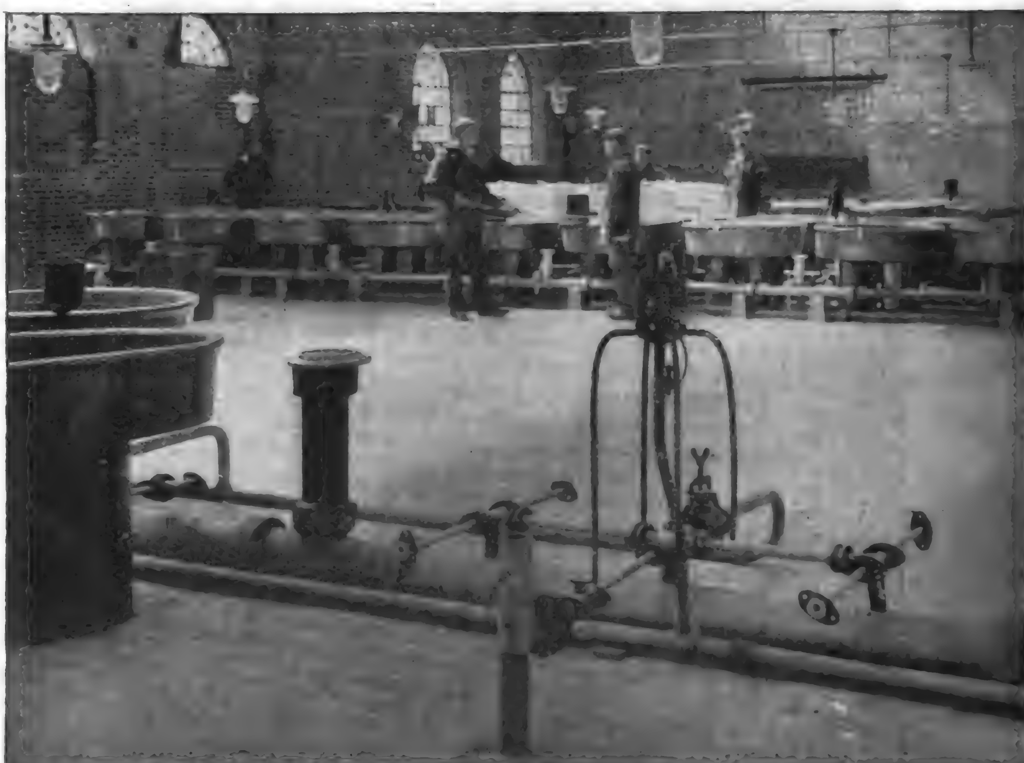
Revivification is nowadays very frequently carried out with sulphuric acid containing 20 per cent. of sulphuric anhydride (Oleum). This reduces the excess of waste acid very considerably, but, as I have said, it ought to be ascertained whether the resulting nitro-cotton is not affected thereby.

The immersion of the gun-cotton, removed from the centrifugals, is chiefly carried out by direct dipping into water, but one factory conveys it since a long time in a lead gutter along with a large quantity of water, whilst a similar drowning apparatus is largely introduced by Messrs. Selwig and Lange after having been tried in Waltham Abbey and given up on account of its alleged danger.

When the gun-cotton is pulped and finished, it is frequently packed and pressed into boxes. Gun-cotton can become mouldy on the outside through fungi, and, according to von Förster, have its structure destroyed;* and von Förster found this was promoted by paper in the cases, whilst Malenkowicz† showed this to be due to fungi produced by moisture acting on the wood of the boxes. It is very important to select proper packing material on account of the possibility of detrimentally influencing the stability.

A new process for the nitration of cotton is due to Messrs. James Milne Thomson and William Thomson, of Waltham Abbey,‡ and it has already been introduced in some factories. An earthenware funnel-shaped vessel can be connected at its stem by means of cocks either with a pipe supplying fresh acid or with a discharge pipe. An earthenware grating closes the opening of the stem,

FIG. 4.



NITRATION OF COTTON. (Thomson's Patent Displacement Process.)

* "Max v. Förster, Versuche mit comprimirter Schiessbaumwolle." Berlin, 1883, p. 11.

† "Mittheilungen über Gegenstände des Artilleriewesens," 1907, p. 599.

‡ British Patent, No. 8278, of 1903.

the new acid is introduced, the cotton dipped in it the usual way, and then segments, made of perforated earthenware plates, are laid on top so as to immerse the cotton completely. A small vessel with four outlets is now laid on top, and a Segner wheel distributes water evenly into it, and this is so regulated as to flow out quite slowly and lay itself on the top of the acid without disturbing the latter. This layer of water retains all fumes that may arise from the acid, so that the air in the room is quite good. When nitration is finished, water is again allowed to run in, but at the same time connection is made with the outlet pipe, and the flow of the water being carefully regulated, it gradually displaces the acid. Finally the nitrocotton can be given a preliminary washing.

The advertisements of the makers of the apparatus state that only 0·4 per cent. of acid are lost, and that the acid recovered is as to 70 per cent., with 9·7 per cent. of water; and as to 30 per cent., with 20 per cent. of water. With the ordinary processes practically an equal amount of acid is retained by the gun-cotton; therefore when using say 30 acid to 1 cotton, about 3·5 per cent. of waste acid are lost; on the other hand there is no weak acid produced, but it all has 10 per cent. of water only. This process gives very good results, and is very convenient for making gun-cotton, as required by the British Government, which may contain a fairly large percentage of soluble nitrocellulose. As yet there are hardly sufficient data available to decide whether the displacement process will give equally good results for gun-cotton with a small percentage of soluble, or, what is far more important for smokeless powder, whether it will enable a soluble nitrocellulose with definite properties to be made, which, as is known, is always a somewhat difficult matter.

The only improvement made in the working up of finished gun-cotton has been patented by Hollings,* and further improved by others. It is a special method of compression, whereby large charges, such as for shells, torpedoes, &c., can be made in one piece, instead of having to be composed from a number of segments, and then turned on a lathe.

Of other modifications of cellulose very little use has so far been made. There is no need for me to dwell upon the defects of nitro-sugar and nitro-mannite, &c.; but nitro-starch, which is so tempting, has often been tried, but it was impossible to make it stable; besides, nitro-starch could not be nitrated so highly. It was, therefore, somewhat of a surprise when Arthur Hough, of New York,* announced that he could nitrate starch so as to contain at least 16 per cent. of nitrogen. He did this by dissolving the starch in nitric acid at a temperature of 90° F., and precipitating the nitro-starch by passing gaseous sulphuric anhydride through the solution. In a later patent he altered his process by nitrating the starch with a mixture of three parts of nitric acid of 95 per cent. monohydrate, and two parts of 98 per cent. sulphuric acid, and adding so much sulphuric anhydride to it as to have a concentration of 100 per cent. with one to two per cent. of free SO_3 in the solution. Further, during nitration he injects more sulphuric acid having an excess of about 2 per cent. anhydride into the mixture, and in this way he obtains nitro-starch, which is almost wholly an octonitrate [$C_{12}H_{12}(NO_2)_8O_{10}$] and contains about 16·5 per cent. of nitrogen. You will remember that Hoitsema† has already studied the possibility of producing higher cellulose nitrates than hexanitrocellulose, by keeping up the strength of the acid with phosphoric anhydride. Hough seems to have found the practical solution. This nitro-starch has been utilised in the manufacture of smokeless powders, and I understand that it is used to a certain extent in the United States Army.

* British Patents, No. 19806 of 1898, and 23449, of 1899.

* British Patent, No. 12527, of 1904.

† "Zeitschrift für Angewandte Chemie," 1898, p. 173.

DIFFICULTIES IN THE CONSTRUCTION OF AEROPLANES.

By Herbert Chatley, B.Sc.

In the papers delivered by Major Baden Powell and Dr. Hele Shaw during the last two sessions, and by Mr. Eric Stuart Bruce in this session, the general problems and present position of aerial navigation were fairly exhaustively treated; and, after such eminent authorities' treatment of the subject, it would be quite superfluous again to specify the fundamental principles. The author's object is, therefore, to describe some of the difficulties which occur in applying those principles to the construction of actual machines. It is needless to point out, however simple the root principles underlying the design of any machine may be, when the machine is to be built, ex-

tremely complex combinations of principles appear, so that the practical man is saddled with far more burdensome troubles than those which hamper the theorist.

A study of the various machines in existence has led the author to notice the following difficult problems:—

(1) The determination of the relation between the area and weight.

(2) The adoption of a prime mover and propeller suited to the required speed and manipulative efficiency.

(3) The arrangement of the weight and supporting surfaces to give permanent stability and dirigibility.

(4) The selection of accessory appliances.

There are certain other points to be considered in a free development of the subject, but there will be enough to do in tackling these.

Area and Weight.

If we presuppose that the machine is of the type having plane or nearly plane supporting surfaces and a positive angle, it may be said that the long series of experiments from Vince to Langley has conclusively shown that the lift depends on the area, the square of the relative velocity and (approximately) the sine of the angle. These three quantities may be varied so as to give a lift slightly exceeding the weight, but the range through which they may be varied is not unlimited. Thus there is a minimum value of the velocity (corresponding to an angle of about 25°), and the angle may not be decreased much below 2° nor increased above 30° without impairing the mechanical efficiency. Similarly the area cannot be greatly increased without increasing the weight.

On the face of it, the determination of the area would seem to be somewhat difficult, since a weight driven by large power at a large angle needs (comparatively) small area, and the same weight driven by small power at a small angle needs (comparatively) large area, the starting velocity being the same in each case.

A Dutch naturalist, Harting, discovered an approximate law for the relation between the area of a bird's wing and its weight, which seems peculiarly applicable, and the author has reduced it to English units (slightly increasing the constant) as follows:—

$$\text{Area (square feet)} = 6\ (\text{weight in lbs.})^{\frac{2}{3}}.$$

This works out very nearly to all cases of natural flight, and leads in the case of machines, such as are now experimented with (weight, say, 1,000 lbs.) to a ratio of area to weight $= \frac{3}{5}$, *i.e.*, each square foot lifts $1\frac{2}{3}$ lbs. Some machines use larger areas, and, in consequence, need much more power; but, on the other hand, the starting velocity may be much lower.

This would indicate (as is indeed already well known) that the heavier the machine, the smaller may be the supporting surface. Thus, if the weight is 1,728 lbs., the area in square feet is half the weight in lbs., and if 2,397 lbs., the area in square feet is one-third the weight in lbs.

This question may well be concluded by a comparison of the areas of some machines with the above law:—

Name	Weight.	Ratio of Weight to Area.	Ratio of Weight by Law.
Maxim	7,000	2·3	3·18
Santos Dumont, 14 Bis	460	0·53	1·286
Farman	1,200	1·79	1·78

The last is a remarkable coincidence. The two previous machines, if the law is true, have an excess of area which may perhaps account for the difficulties experienced in controlling them.

It should be noticed that by adoption of this law, other factors being the same, the necessary soaring velocity varies as the sixth root of the weight.

Motor and Propeller.

At the present time considerable difficulty is experienced in choosing a motor for an aeroplane. Two very light types, the Levavasseur "Antoinette" and Messrs. Dufaux Frères petrol motors, have been evolved, but are subject at present to certain defects by reason of their exceedingly small weight. The experiments that have been made up to the present show that one effective horse-power will lift about 100 lbs. at a speed of 30 miles per hour. Since, however, the combined efficiencies of gearing and propeller rarely exceed 50 per cent., this only means 50 lbs. per B.H.P. Making a fourth allowance for travelling at a somewhat lower speed a lift of about 30 lbs. per B.H.P. can be relied on, so that a rough notion of the B.H.P. necessary can be obtained by the following rule:—

$$\frac{\text{Weight of machine without motor}}{35} = \text{B.H.P. needed.}$$

This allows 5 lbs. per horse-power for the weight of the motor. The Dufaux motor, which holds the record for lightness, consists

(in the 120 horse-power set) of ten cylinders, directly paired and double acting, overhung shaft, water-cooled cylinders, and air-cooled piston. The Esnault-Pelterie motor should also be mentioned in this connection, since its weight is nearly as low as the other two types, and it seems very fairly efficient.

In almost all the later machines the flywheel is dispensed with, uniformity of torque being maintained by balancing the pistons carefully. The kinetic energy stored in the propeller is also relied on to some extent.

As to the propeller itself, there is considerable diversity of opinion, but in nearly all cases it has been found preferable to use fan-bladed propellers with two, three, or four blades. The two-bladed type gives seemingly the best results, owing to the arrangement giving a minimum disturbance of the air. The author does not propose to give any formulæ in relation to the propeller since the final rule of thumb methods used by the French school of aviators were given by Captain Forbes at a meeting of the Junior Institution of Engineers in February, 1908. He would, however, mention certain points worthy in his opinion of consideration.

(1) By using superposed blades the thrust can be greatly increased. (Mr. Walker's experiments have proved this up to the hilt.)

(2) A further increase in the thrust is obtainable if aerocurves of the form instituted by Mr. Phillips are employed. [The author is aware that some inventors are using curved blades, but there does not seem to be any uniformity in the attempts.]

(3) A minimum of slip is desirable. (This was shown by Professor Langley's dynamometer experiments, and also may be deduced from the results of the late Mr. Froude in regard to water.)

Hence it is desirable to run the propeller at only a little above the normal speed of the aeroplane. There is here a difference from marine practice due to the difference between air and water friction. (See Mr. Froude's "Elementary Relations between Ship, Pitch, and Propulsive Efficiency." Transactions, Institute Naval Architects.) As to the method of transmission of power from the motor to the propeller, this will largely depend on the speed at which the propeller is to run. The Dufnaux 120 horse-power set is designed to run at 1,500 r.p.m., but of course a small area and diameter propeller would cause the engine to race until the cross resistance produced a torque equal to that corresponding to the power and speed. If we say that the maximum speed desirable is 60 miles per hour (on a certain machine), and assume a propeller velocity of 65 miles per hour (say 100 feet per second), we fix the revolutions by the pitch, or *vice versa*. If the motor can efficiently run at the determined propeller speed, then (as is at present usually the case) the shafts will be direct coupled. At present there is scarcely any machine which has the propeller well under control, *i.e.*, can be stopped and started, altered in speed, &c., without stopping the motor. This is due, of course, to the weight of clutches, change speed gears, &c. Probably some of the enterprising firms who have shown an interest in this subject may produce suitable gear for this purpose.

Arrangement of Supporting Surfaces.

This problem is the most difficult of all, and is perhaps to us the most interesting, seeing that it is by no means completely solved.

As Major Baden-Powell showed the Society in 1907, the laws relating to the stability of surfaces sustained by the displacement of air are comparatively complex. He quoted the now well known law of Captain Joëssel as to the displacement of the centre of pressure to a position anterior to the centre of surface on a plane with a position angle. Kummer and Langley have shown that this displacement is less on planes narrow in the direction of motion, and more on planes long in the direction of motion, than Joëssel's law indicates, unless the angle of inclination exceeds 30°. Above this angle the relation is reversed. An analogous change takes place in the pressures on the planes. This eccentricity of the centre of pressure renders an unbalanced simple surface unstable, being subject to a torque = weight × displacement of c.p. from the c.g. If a weight be attached at such a distance from the c.g. that this torque is balanced for that particular wind pressure and angle, the plane is stable, and if the weight can be rapidly adjusted, balance in many positions is possible. This is the principle of the kite tail, and is employed in José Weiss' "Albatross" gliders, which consist of a torpedo or cigar-shaped body, containing a central shaft, along which slides a leaden weight, the supporting surfaces being "pterygoid aerocurves," *i.e.*, wing type curved surfaces.

Mr. Esnault Pelterie's latest machine (March, 1908) seems to consist of a somewhat similar arrangement, but the planes are

dihedral (*i.e.*, inclined downwards towards the central body).

Another method of balancing is to use two surfaces separated by a sufficient space to prevent mutual disturbance of the air currents. The pressure on the two surfaces causes a balance (in steady motion) about a point between the surfaces. This again leads to a type of machine. Langley's aerodrome, Bleriot's new machine, and Messrs. Mangin and Gastambide's aeroplane, all show this feature. Laterally, they consist of dihedrally arranged planes, and longitudinally, a pair of similar sets.

The superposed type, and cellular or box type, respectively due to Chanute and Hargrave, next call for attention. The superposed type gives additional lift, without increase of length, and is, in the case of the Phillip's machine, carried almost to its limit. The cellular type owes its efficiency to the impressing of a definite course to the current, and so decreasing the variability of the pressure.

Finally we come to a compound type, which has been the source of the French types, which lately have proved successful, viz., the Chanute glider. This consists of a longitudinally-paired, but unequal system of superposed and cellular sets. In front we have two superposed planes attached by means of a central girder to a rear cellular set. This arrangement possesses remarkable stability. A method of constructing such a glider was described by Messrs. Voisin Frères in *Knowledge* last year. A collaboration between Mr. Octave Chanute and Captain Ferber, furthered by the individual enterprise of Messrs. Voisin Frères, caused several machines to be evolved from the Chanute glider. Among these the Bleriot-Voisin, Archdeacon-Voisin, Farman-Voisin, and Delagrange-Voisin machines are best known. The last two now hold the record for aviation.*

On the basis of these preliminary types, the author has worked a scheme of classification, as follows :—

Longitudinal arrangement.

1. Paired sets.—(*a*) Anterior and posterior equal — *e.g.*, Archdeacon, Phillip's I., Langley, Ludlow, Bleriot ; (*b*) Anterior set larger than posterior set—*e.g.*, Farman, Delagrange, Ferber, Santos Dumont XIX, Chanute ; (*c*) Posterior set larger than anterior set—*e.g.*, Santos Dumont XIV. *bis*, Roe.
2. Single set.—*e.g.*, Weiss, Vuja, Esnault-Pelterie, Wright Bros.

Vertical arrangement.

1. Superposed planes for both sets.—*e.g.*, Phillips, Bleriot, Ludlow, Bellamy.
2. Superposed anterior set, cellular rear set—*e.g.*, Chanute, Farman, Delagrange.
3. Cellular anterior set, cellular rear set—no examples.
4. Cellular, both sets—Archdeacon, Santos Dumont XIV. *bis*.
5. Single planes for both sets—Langley, Bleriot VII.
6. Front set single, rear superposed—Roe.

Lateral arrangement.

1. Dihedral—*e.g.*, Santos Dumont XIV. *bis* and XIX., Ludlow, Esnault Pelterie, Langley, Vuja, Mangin and Gastambide.
2. Monoplanar—*e.g.*, Farman, Ludlow (combined with Dihedral "Tetrahedral"), Archdeacon, Bleriot, Roe.

Form of planes.

1. Uniplanar — *e.g.*, Maxim, Langley, Wright Bros., Archdeacon, &c.
2. Curved—*e.g.*, Phillips, Farman, Vuja, Delagrange.

By means of this scheme it is possible to draw up a specification of the supporting surfaces for any machine. The majority of the machines referred to have made flights of a more or less satisfactory kind, and in the present state of knowledge it is difficult to say which of the types is the best. The Farman-Voisin machine certainly has given the best results to the present, and it is noteworthy that the new Delagrange-Voisin machine, built on exactly the same lines, is equally efficient.

It will perhaps be useful to give the specification of this type (see Table, p. 141).

Longitudinally paired, front set two superposed planes, slightly curved. Posterior set cellular, and smaller than their front set. Both sets laterally monoplanes. Framing consists of two transverse lattice girders united by one axial girder. Propellers between the sets, and aeronaut's car between the superposed planes. [Steering planes will be referred to later.] The centre of gravity will lie somewhere near the motor (at the back of the superposed planes), so that the pressure on the rear set × distance from the c.p. of that set to the common c.g. = pressure in front set × distance from c.p. to the common c.g., thus assuming initial balance.

* This was written before the recent records made by the Bros. Wright.

Against the assumption that this is the best type the following facts must be set :—

(1) Langley's aerodromes gave very satisfactory results with a much simpler system of planes.

(2) All the more recent machines (including Farman II., Santos-Dumont XIX., Bleriot VII., Mangin and Gastambide, Esnault-Pelterie) incline towards the Langley dihedral type.

(3) There is apparently little reserve of lateral stability.

1. *Separate sets for vertical and lateral steering.*—In this case approximately horizontal planes (or one plane) are placed in front for vertical steering and a vertical plane or planes for lateral steering at the rear. The axes of vibration lie in a median plane. Examples—Farman I., Wright Bros.

2. *Cruciform set.*—Vertical and horizontal planes intersecting one another at right angles are used in the following machines :—Langley, Bellamy, and Ludlow.

3. *Cellulose set.*—A single box set revolvable about an axis placed in front. This was used in Santos Dumont XIV. *bis*, but does not seem to have been regarded by him or other aviators as satisfactory. Captain Ferber considers it should have been placed in the rear of the machine.

Table of Machines.

Name.	Longitudinal.	Lateral.	Vertical.
Maxim	Single	Dihedral	Superposed
Langley	Equally paired	Dihedral	Monoplanar
Santos Dumont XIV. *bis.*	Unequally paired	Dihedral	Cellular
Santos Dumont XIX.	Single	Dihedral	Monoplanar
Farman I.	Unequally paired	Uniplanar	Superposed
Farman II.	Multiple	Dihedral	Monoplanar
Delagrange I.	Equally paired	Uniplanar	Superposed
Delagrange II.	As Farman I.		
Bleriot-Voisin I.	Unequally paired	Uniplanar	Superposed
Bleriot VII.	Equally paired	Dihedral	Monoplanar
Esnault-Pelterie	Single	Dihedral	Monoplanar
Archdeacon	Equally paired	Uniplanar	Superposed and cellular
Mangin and Gastambide	Paired	Dihedral	Single
Roe	Unequally paired	Uniplanar	Superposed
Moore-Brabazon	Paired	Uniplanar	Superposed
Phillips I.	Paired	Uniplanar	Superposed
Ludlow	Equally paired	Uniplanar and dihedral	Superposed
Bellamy	Equally paired	Uniplanar	Superposed
Wright Bros.	Single	Uniplanar	Superposed
Howard	Single	Dihedral	Monoplanar
Kapferer	Unequally paired	Uniplanar	Superposed
Weiss	Single	Uniplanar	Monoplanar
Types.			
Langley	Equally paired	Dihedral	Monoplanar
Chanute	Unequally paired	Uniplanar	Superposed and cellular
Archdeacon	Equally paired	Uniplanar	Cellular
Penaud	Single	Dihedral	Monoplanar

The final choice seems to rest between the Farman-Chanute glider and the Langley dihedral type. In favour of the former are the superposed surfaces the use of which decreases the length and spread of the machine. The latter has the advantage of equal balance and less interference with the action of the rear set. Certainly if the sets are unequal the front should be the larger, so that the centre of gravity of the machine should be nearer to it than to the rear. If the sets are equal then superposed or cellular types must to some extent reduce the lift on the rear set. As to steering planes we have several varieties :—

4. *Single large plane.*—Mr. A. V. Roe, in 1907, showed some models in which steering (both vertical and horizontal) was performed by the rear or front set of a paired system consisting of a single plane. This could be rotated through a small angle about a horizontal axis through the centre of pressure for vertical steering, and twisted (up one side and

down the other on a diagonal) for lateral steerng. His large machine at Brooklands (1908) is constructed with the front set arranged in this way. The motor is placed just in front of the rear set (two superposed planes), and the aeronaut's car in under the front plane.

5. *Small planes at tips of dihedral planes* are used in the last Bleriot machine on the front set only, revolvable about axes passing through the dihedral planes.

Several types (chiefly those used for gliding experiments only) have simply front vertical steering sets, consisting of single planes (*e.g.*, Archdeacon) superposed planes (Bleriot-Voisin I.) and box sets. It is of course essential in all cases that the steering planes shall be symmetrically arranged about the longitudinal axes.

The position of the propeller is another important point in this connection, and we have the following varieties of treatment:—

(1.) *Propeller, single and at rear.*—Santos-Dumont XIV. *bis*, Roe.

(2.) *Propeller, single and in front.*—Bleriot VII., Esnault-Pelterie, Vuja, Santos-Dumont XIX., Phillip's (1908).

(3.) *Propeller, single and between the sets.*—Farman I., Bleriot-Voisin I.

(4.) *Two propellers between sets.*—Langley. This question is not yet settled by any means. The propeller at the rear has a free discharge, but, on the other hand, its feed is disturbed. In front it has a clear feed, but is hampered in discharging, and also modifies the streams impinging on the supporting planes. Also, by increasing the relative speed of the air, it causes considerable friction on those planes: Paired screws, if separately driven, would, of course, be very useful in assisting lateral steering, but involve complex and weighty mechanism. Centrally placed screws are more likely to be fouled by broken tie wires, &c., and, if the propeller breaks, the machine may have its main girder destroyed. An important point in this connection is the position of the motor. If the propeller is in front while the motor is (on account, say, of the form of the supporting planes) at the rear, there is a maximum of shafting and bearings, with consequent increase of weight.

Passing to the details of construction of the planes, in nearly all cases the great difficulty is permanence of form. Generally, cross bars (bent to the curve of the plane) are fitted to the booms of the main girder, and stiffened by struts mortised through the cross bars, trussed to the ends of the bars by steel wire, and cross trussed to adjacent bars in the same way. The cross bars (which form, as it were, the ribs of the surfaces) should be as flat as possible, and the struts should be edge on to the direction of motion so as to present a minimum of resistance. In some cases they are nicely eased away so as to give roughly streamline forms. Joints are preferably solid, *i.e.*, made with special socket pieces cast in an aluminium alloy. Messrs. Voisin Frères, for experimental gliders, recommend an "H" form of sheet metal, which can be bent round a trihedral joint and clamped with one small bolt over the members to be joined. To this bolt the stay wires can be fastened. The shearing forces in the girders are resisted by verticals and the stay wires. The latter, to avoid the use of the heavy, diagonal struts, are strained across both diagonals. In some machines the joints are made sufficiently solid to avoid the use of bracing wires. If weight permits this would be much preferable, as the wires are very troublesome when broken. The author understands that very little trouble is experienced with slackening of the wires if properly arranged in the first place, but some method of tightening would seem to be essential, particularly to accommodate the slight permanent set which will occur during the first flight of a new machine. It is noteworthy that the dihedral type lends itself to lateral stiffening far more than the monoplanar type. As a matter of fact, in the author's opinion, the engineering skill shown in the structural arrangement of the Langley aerodrome cannot be over-estimated.

Accessories.

This term covers in the case of an aeroplane a rather wide field, and it will perhaps be as well to specify those accessories which merit special consideration. They may be split into two groups: those forming an essential part of the machine, and those which are useful but not in all cases indispensable.

Among the former the author includes

(1) Wheels and springs for starting and alighting.

(2) Motor-controlling gear.

(3) Steering gear other than the rudder planes themselves.

(4) Aeronaut's car.

The second group comprises the instruments required for navigation, lights, &c., scarcely any of which are yet necessary.

The question of wheels and springs for earth contact is a very serious one. All machines

which have any claim to success have at some time or another been damaged to a greater or less extent in rising or falling. Some engineers, including Mr. Rankine Kennedy, take such a pessimistic view of the question of falling as to pin their faith to the direct acting hélicoptère. The author, while much interested and within certain limits believing in the efficacy of that machine, cannot nevertheless endorse this opinion. The gliding experiments made by Lilienthāl, Pilcher, Chanute, Ferber, Herring, Archdeacon, Voisin, and Bleriot generally lead to the conclusion that a large proportion of gliding descents (without propellers in action) can be safely made. In the classical paper by Lord Rayleigh, delivered in 1900 to the Manchester Literary and Philosophical Society, this question is studied mathematically. The hélicoptère undoubtedly is safer while the engines work. If they stop it seems very unlikely that the parachutic action of the screw surfaces will prevent disaster, whereas with an aeroplane a degree of safety is assured. Nevertheless there is bound to be a shock when reaching the ground, and this must be mitigated to some extent. The springs must have an available stiffness at least equal to twice the weight of the whole machine, and they should come into action however the machine may descend. This latter condition it is, of course, very difficult to realise.

A general arrangement is to combine the wheel and springs in a somewhat similar manner to the mounting of a locomotive. Horn plates, attached to the main girder, carry the bearings of the wheels, helical springs being inserted between the upper bearing block and frame, so that, on impact, the springs are compressed by the bearing block rising between the horn plates. Seeing that, on descent, the machine is usually running forwards, the horn plates might perhaps be advantageously inclined downwards and forwards, so that the resistance is, to some extent, in the direction of motion.

Solid rubber tyres on wheels, about 12 inches in diameter, are sometimes employed. Captain Ferber and M. Vuja use a four-wheeled central carriage. The Bleriot VII. machine has three wheels, the odd one being at the rear. The Farman I. machine has two large wheels in front planes, and two small ones under the rear set. M. Esnault Pelterie has three wheels under the body, and also two small wheels on the tips of the dihedral planes. Messrs. Moore-Brabazon and the Wright Brothers use runners, but this arrangement would seem to prevent re-starting after descent.

Carriage types of spring have a larger area of action than helical springs, but on this very account are more likely to damage the frame if subjected to excessive forces.

Motor-controlling gear.—At present this only includes the following:—(1) Throttle valve lever, (2) exhaust valve lever, (3) air supply lever.

The control-board will in most cases have to be some distance from the motor (this is not so in the Farman I. and Santos Dumont XIV. *bis* machines) so that communication wires running over guide pulleys are generally required. The actual hand levers may be quite small and work in quadrants with stop grooves and spring catches. If possible they should all be so close together that one hand only is required for operating them.

Brakes, clutches, and change speed gears not yet being employed need not be referred to now, but in the larger machines which will be built some or all of these will undoubtedly be fitted.

Steering Gear.—One of the most ingenious arrangements I have seen is that employed by Mr. Roe. A small steering wheel and shaft (as for a small motor-car) is arranged so that it can be rotated on its axis and also work on a transverse axis. By drawing the wheel and shaft backwards or forwards the horizontal plane is rotated for vertical steering, the motion being transmitted through steel wires. By rotating the steering wheel the same plane is twisted to steer laterally. A similar arrangement could doubtless be employed for controlling a vertical rudder plane.

In all cases, whether levers or wheels are employed, the arrangement must be double acting, *i.e.*, have wires above and below the axis of rotation of the lever so that the wires are in tension on both the backward and forward movements. Otherwise stiff levers (necessarily of appreciable weight) must be used. In cases where a rod to transmit a thrust is indispensable, a fairly stout rod may be stiffened to resist crippling by fixing a cross of struts at its centre, with stay-wires from the vertices to the ends of the rod.

Aeronaut's Car.—Although this may seem at first sight a minor matter, yet there are several very important considerations involved. A very slight movement on the part of the aeronaut causes a disturbing torque on the machine, so that it is essential that the car should be so placed that

the controlling levers are easily accessible without moving the body. On the other hand, as aeroplanes are arranged at present, it is desirable that when necessary the body should be free to move so as to apply a torque to assist in steering. (Thus Mr. Farman found it necessary to throw his weight in different directions to perform various turning movements.) Further, the car should be so arranged that it is easy to enter and also to leave in the event of accident. On the other hand, there must of course be no chance of being thrown out.

Most machinists have the car in the framing of the longitudinal girder. Its exact position will of course depend on the centre of gravity of the machine *without* the aeronaut, for so long as the machines are of such a size that the weight of an aeronaut has an appreciable ratio to the weight of the machine, his position will be of vital importance to the balance. Even a difference in his weight of a few pounds is now important, just as in balloons. It is, however, noteworthy that recently Mr. Farman and Mr. Delagrange have been able to ride together in Mr. Delagrange's aeroplane. Seeing that the weight of the aeronaut is thus variable, it would be well if the car could be placed at the general c.g. Under these circumstances the increase in weight will involve a higher soaring velocity, but will increase the stability, since the mass subject to disturbing torque is greater.

Among the appliances which may be necessary and form integral parts of the machine are balancing devices other than steering planes. The more important of these are (1), moving poise weights, and (2) gyrostatic appliances.

The author has already referred to the poise weights used in the Weiss gliders, and he is inclined to think they may be made of much assistance in vertical steering. Operated by leading screws driven by a wheel and worm or by levers in the "lazy tongs" method, such weights could be rapidly moved to balance a disturbing torque or to provide a steering torque. The personal element would, however, still occur.

Gyrostatic appliances consisting of vibrating pendula or rotating flywheels, are capable of converting a disturbing torque about the axis to one about an axis at right angles, or if the motion be accelerated (as in the Brennan memorial gyroscopes), a direct balancing torque may be obtained. Major Baden Powell (see letter to *Nature*, January, 1907) has expressed his opinion that such appliances are unnecessary. This opinion does not, however, seem to be universally held, and certainly any device which excludes the personal element would seem preferable for large machines.

Passing to the accessories which at the present time are not absolutely necessary, navigating instruments may first be referred to, and would include compasses, barometers, thermometers, anemometers, and wind vanes. Compasses are of course not necessary until much longer voyages are undertaken, but when used must be of the gimbal-hung type.

Barometers, on account of the motion, would need to be of the aneroid type. The readings would, however, be very difficult to correct for on account of the forced pressures and uncertain motion of the air. Anemometers would indicate the relative speed of the air, and wind vanes the relative direction. In conjunction with observations of the land, it would be possible to find the true direction of the wind at any time.

The author will conclude by noticing that in no sense may we regard our present knowledge of the subject as exhaustive. As has been pointed out by Dr. Hele-Shaw, a long time must elapse before our knowledge of airships is at all comparable with that which we now possess as to ships. Before definite conclusions can be obtained as to the action of the air under all conceivable circumstances, great advances must be made in meteorological research. More accurate information is needed upon the direction and velocity of the wind. It is known that the air currents, by reason of the friction against the ground, have often a considerable vertical component, and Lord Rayleigh has shown that we must attribute to this fact much of the efficiency of bird flight. As to the velocity of wind, Professor Langley's work on the "Internal Work of the Wind" and Sir Benjamin Baker's anemometer records at the Forth Bridge have considerably advanced our knowledge in this respect, but much has yet to be done by both scientists and aviators. It is quite conceivable that the pulsations in the air currents may be employed to increase considerably the mechanical efficiency of an aeroplane.

However this may be, there can be no doubt that the subject is now being definitely evolved. The author can only regret that Englishmen have as yet done so little. Frenchmen, Americans, and Germans have, it cannot be denied, done the best work hitherto. Let us do better.

THE MINERAL AND AGRICULTURAL DEVELOPMENT OF THE MALAY STATES.

The Federated Malay States, comprising Perak, Selangor, Negri Sembilan, and Pahang, have an estimated area of 26,380 square miles and a population of about 900,000. Pahang is the largest of these States, covering nearly half the combined area, and Perak is the richest and most important. The land slopes to the coasts from a central mountain range, with heights of 3,000 to 7,000 feet, and is everywhere covered with a dense tropical forest of large trees, most of which are over one hundred feet high. From this watershed flow innumerable streams, some of which are navigable for small steamers fifty miles from the sea. Among the natural resources of the States are tin, gold, lead, iron, copper, zinc, &c. Tin is by far the most important, furnishing about 60 per cent. of the world's production. The American Consul at Singapore says that only alluvial surface deposits have so far been worked, and these only in a primitive Chinese fashion. The last year for which statistics are available showed a falling off in the quantity of tin produced, due to the fact that the different mines were not equipped with the necessary machinery to mine the lower grades of ore successfully. This condition has been in a large measure remedied by enterprising mine owners, and, as a result, there will probaby be additional development of new deposits, and a greatly increased production. A small quantity of gold is mined. There are other metals as yet untouched which are doubtless of great value. Forest products comprise gutta-percha, rubber, rattans of many varieties, vegetable oils, resins, gambier, tapioca, sago, rice, and spices, principally pepper. Among the fruits are the mangosteen, banana, apple, lime, durian, cocoanut, pine apple, guava, orange, mango, and many others. The equable climate is especially favourable for agriculture, in that it causes a constant growth. As a result, all crops, annual or perennial, show greater progress than the same plants during the same time in countries like Ceylon and South India, where prolonged periods of exceedingly small, or absolute lack of rainfall, check the growth. Rubber is the chief agricultural product. At the beginning of 1907 there were 242 estates, with 10,745,000 trees, an increase of 4,000,000 over the preceding year, and a total acreage of 85,579 acres, an increase of 45,000. The output of dry rubber was 130 tons in 1905 and 385 tons in 1906. At present there are employed regularly in estate work 70,000 coolies. The cultivation of the cocoanut ranks next in importance. The area under cultivation at present is over 105,000 acres, an increase of five per cent. over that of a year ago, and more than one-half this area is bearing. At an average of 40 nuts per tree, the yield if converted into copra would amount to over 50,000 tons, with a large and valuable stock of fibre for the manufacture of coir matting, rope, &c. Recent experiments have been made with the propagation of camphor by means of cuttings. The first trial of some thousands of trees was not successful. Some plantings of cuttings only a few feet above the sea level have attained in two years a height of twelve to fourteen feet. All official reports point to increased activity in every line of business, and the proposed public improvements, providing particularly for better means of transport, must, when completed, add greatly to the wealth-producing capacity of the country. Much progress has already been made in the solution of transportation problems.

NATAL WOOL TRADE.

While the wool trade of Natal has passed through many vicissitudes, it is said to have good prospects. From the earliest days of settlement wool has been one of the chief articles of export from Natal, and, although other things, such as coal, wattle bark, and maize, have lately come into the front rank of exports, wool still remains, and will continue to be, one of the greatest assets of that part of South Africa. In the year immediately preceding the Boer war, wool exported from Natal averaged nearly 70,000 bales per annum (about 23,000,000 pounds), resulting in a steady and substantial profit to the farmer. The war reduced the exportation of wool to one-fifth of its former quantity, according to the American Consul at Durban. Since then pastoral industries have been recuperating, and flocks and herds have multiplied until to-day they are nearly as numerous as before the war. The wool which finds its way to the marts of Durban comprises the bulk of the Transvaal production, and perhaps 20 per cent. of the yield of the Orange River Colony, in addition to that grown in Natal. New railways, connecting Natal and the Orange River Colony, have attracted much trade which formerly passed through the ports of Cape Colony. These railways have made Durban the natural port for all the north-eastern parts of the Orange River Colony, and further extensions of railway may bring a still greater proportion of that territory's product to Durban, though Port Elizabeth and East London will probably retain a large share of the traffic of the southern half of the Orange River Colony. The wool produced in the two inland States is pure merino, but on account of poverty of pasture, and consequent dirtiness of the fleece, it is not so much in demand as is the wool of the cross-bred sheep which are bred in Natal. Natal wool is shorter, but being grown on richer pasture its yield, after washing, is of higher percentage than that of the merino grown in the interior. In marketing, the grower puts his produce on rail, or sells it to the inland trader, who in turn dispatches it from the nearest station, consigned to one of the auction marts in Durban. Here it is pressed, still in the grease, into bales, and put up for auction. After purchase at auction, the wool is shipped to England and the continent of Europe, the latter being the chief con-

sumer of the Natal product. The entire output is exported, as the manufacture of woollen goods has not proved very successful in the colony. In the calendar year 1906, the exports of wool from Natal were 17,870,000 pounds, valued at £537,000, while in 1907 the exports amounted to 20,264,000 pounds, valued at £637,000.

WATER TRAFFIC IN EGYPT.

Not so much use is made of water transportation in Egypt as one might think, in view of the possibilities offered by the River Nile and the many canals throughout the Delta. The Nile is a great navigable stream for many hundred miles. The first cataract is at Assouan, but there is no interruption of traffic until Wadi Halfa is reached, eight hundred miles from Cairo. The primary object of the canals is to distribute water for irrigation, but they are really broad and deep watercourses, easily navigable by sailing boats and small steam tugs. The American Consul at Cairo says that shipping could not be allowed to interfere with irrigation, but the canals could be much more used for transport than they are. On the Nile are many steamers and sailing boats, but the greater part of the merchandise is carried by the State railways and light railways. If the canals were to be used great docks and landing places would be required at Alexandria, and landing places would have to be built at many points. None of these things exist. It is a curious fact that the Nile, and most of the canals in Egypt, run north and south. The wind blows nearly all the year from the north, and thus furnishes the cheapest propelling power for boats going south. When the boats return north, the rapid current of the Nile is the motive power. The regularity of the wind and the steadiness of the current are two reasons why boats propelled by any other power are so little used. Time is not so important an element in business in Egypt as in some other countries, and it does not matter, therefore, that boats propelled by wind or current are slow. Formerly, all boats that went under bridges had to pay a tax at each bridge; this tax has now been removed. The principal canals in the Delta are as follows:—In the Sharkia Province—Ismailia Canal (Suez branch), 56 miles; Bar Moes, 33 miles; Bahr el Baggar, 30 miles; Rayah Tewfiki, 24 miles; and Bahr Faccous, 21 miles. The total length of canals in the province is 273 miles. In the Menoufia and Gharbia provinces the total length of the canals is 311 miles, while in the Behera province there are 101 miles, and in the Dagualia province 80 miles. This brings the total in the Delta up to 765 miles—nearly as great as the Nile between Cairo and Wadi Halfa. The great canal Youssef runs from near Assiut to the Fayoum Oasis, and is also navigable. Perhaps the most important canals are in the Beheta province—the Mahmoudie, 47 miles long, and the Rajah Behera, 51 miles.

HOME INDUSTRIES.

The Working of the Patents Act.—The first decision under Section 27 of the Patent and Designs Act, 1907, has now been given, and the observations of the Comptroller (The Comptroller-General of Patents, Designs, and Trade Marks) are being made the subject of considerable discussion. The facts are simple. Two patents, dated in 1900, were granted for the manufacture of slabs, composed for the most part of Portland cement and asbestos, and intended for the use of builders. The invention was also patented in Germany, France, and Belgium; and the Belgian license to manufacture extended to other foreign countries, including Great Britain. The manufacture became established in each of the first-named countries, but the demand in the United Kingdom being small, it was supplied by importation from the Belgian factory. In these circumstances, the German and French manufacturers were, so long as the British patents remained in force, debarred from importing the product into this country. To get over this difficulty, a representative of the French business applied to the Comptroller to revoke the patents upon the ground that the patented article or process is being manufactured, or carried on, exclusively, outside the United Kingdom. The Comptroller held that Section 27 of the Patents and Designs Act required him to revoke the patent, and in the absence of "satisfactory reasons why the article or process is not so manufactured, or carried on" in the United Kingdom, he would seem to have had no option. It is not the Comptroller's decision, but rather his observations in giving his decision, which have attracted attention. "The trade," he remarked, "will be freed, and liberty given to import the patented article, not only from Belgium, but also from France and Germany, and any other country in which it may be produced." And the Comptroller not only stated what would be the result of his decision, but added "If the patents are revoked . . . this revocation will undoubtedly have one beneficial result, for it will free the trade in the patented article and enable French and German manufacturers to import it freely into this country." And again, "The trade will be freed and liberty given to import the patented article, not only from Belgium, but also from France and Germany, and any other country in which it may be produced." The Comptroller describes this untrammelled importation as the "beneficial" effect of the Act, but, however that may be, it will hardly be disputed that the result is the opposite of that which Section 27 was intended to bring about.

Piracy of Trade Marks.—Mention has been made in these Notes more than once of the piracy of British trade-marks and trade names in Japan, and similar complaints come from the Argentine. A representation upon the subject made by the Birmingham Chamber of Commerce to the Foreign Office has evoked an important statement from Sir Edward

Grey. The Secretary for Foreign Affairs says that the Patent Bureau at Tokio are anxious to protect the rights of trade-mark owners, but the difficulties of doing so are greatly increased by the failure of foreigners to comply with the necessary conditions. In many cases no registration has been made by foreigners, especially in the case of the old-established trade-marks, where the owners appear to think that any action to secure their rights is superfluous, the consequence being that other parties register such marks, and where the registration has remained unchallenged for three years the real owner is unable to assert his title. The officers of the Patent Bureau cannot prevent such cases as long as they have no record placed in their hands by the original proprietor of the mark. Sir Edward Grey goes on to point out that even where registration has been effected very few foreigners add the words "Registered trade-mark," or the Japanese characters representing Toroku Shohyo (registered trade-mark) in preparing their labels.

The Status of Auctioneers.—The Auctioneers' Institute, founded in 1886, has now a membership of over 22,000, and the Council of the Institute is anxious to raise the status of its members by getting it incorporated by Royal Charter. From the public point of view there would seem to be a good deal to be said in favour of the suggestion. In these days of stress and competition men are tempted to resort to doubtful methods but the thought that such practices are condemned by the Association of which they are members, and which gives a sort of warranty of respectability, acts as a deterrent to wrong doing and a stimulus to honourable dealing. The tendency of the times is to raise the standard of qualification for the auctioneer's business, and after March next the Auctioneers' Institute will be closed to all but those who have passed a certain examination, the object being to restrict the membership to capable and responsible men with a reputation for doing their business in an honourable manner. When the late Mr. Gladstone was at the Exchequer it was suggested to him that the auctioneer's fee might be advantageously raised to £50, but Mr. Gladstone thought that so high a fee would press unduly upon the country auctioneers.

Concrete Piling.—The simplex concrete pile, which has been used in the United States for some years past, seems likely to find a market in this country. A newly-erected and extensive machine shop at the Coventry Ordnance Works, Scotstown, Glasgow, and the new buildings of the Wallpaper Manufacturers, Limited, at Greenhithe, Kent, are erected on these piles, which were also used on the foundations of the engine and machine shops of Messrs. Cammell, Laird and Co., at Tranmere Bay, Birkenhead, and a rotary plant for Messrs. Crossfield and Sons, Limited, Warrington. The cardinal principle of the system consists in driving a hollow tube or form of sufficient strength, and of the desired diameter, generally from 16 inches to 20 inches, the form being fitted at the lower end with a suitable point. After being driven the form is filled with prepared concrete, composed of Portland cement and a suitable aggregate. The form is then withdrawn, and the plastic concrete issuing from the lower end completely fills the space vacated, and in process of setting cements itself firmly into the earth. Steel reinforcements may also be inserted if required. The advantages claimed for the system are unlimited durability (the pile not having been subjected to the strain of driving), exceptional carrying power, due to increased skin friction, and rapidity and economy in construction.

The Cost of Steel Production.—Mr. Carnegie's recent assertion that steel can be made at less cost in the United States than in this country is not supported by figures, or accepted by authorities here. There is no good reason why steel should be made more cheaply in Pittsburg than Sheffield. On the contrary, we have coal, iron, furnaces, and harbours all within easy distance, whereas the enormous distances which separate the iron ore deposits, and the coal fields, and the manufacturing plants from the seaboard in America, severely handicap the American steel trade. In cheap and convenient supplies of minerals, in geographical situation, in sound capitalisation, and in skilful labour the United Kingdom holds a combination of advantages enjoyed by no other country, It may be, says a Sheffield correspondent of the *Manchester Guardian*, that if the comparison is between the prime cost of a ton of American rails rolled from "piped" ingots insufficiently "cropped"—rails of which about one in every four is defective, and the quality of which is deliberately sacrificed to tonnage manufacture—and British rails rolled out of the solid only, Mr. Carnegie's statement may be correct. But, taking quality for quality, it may well be challenged. Between 1900-7, the price of pig iron was on the average about 17s. per ton higher in the United States than in this country. That "price" is not "cost," but there is nothing to show that the American iron smelter, with his high price, has made any greater profit per ton than the British smelter, with his much lower price. With pig iron, ranging from about 6s. to 29s. per ton higher in America than here, it would be strange indeed if it were the fact that the cheapest steel in the world is produced in the United States. Mr. J. S. Jeans—a very high authority on the subject—has said that iron and steel profits are somewhat less generally in America than in Great Britain; and Mr. Gary, the Chairman of the Steel Trust, recently declared that pig iron can be made at 3·65 dols. per ton less in England than in America. In 1906-7 pig iron was about 5 dols. a ton dearer in the United States than in England, and the prices of most other products correspondingly high, yet several of the large American iron and steel concerns were not able to make anything like a stand when financial depression overtook them. Threatened

industries, like threatened men, sometimes live long, and American predictions about British iron goods have been completely falsified. Excessive capital charges hang like a millstone round the neck of American industry: the cost of construction, repairs, and removals per ton of output is extravagant in America as compared with this country, and the capital charges of the independent iron and steel concerns of the United States are roughly three times those of British works, whilst the capital charges of the United States Steel Corporation are about equal to 100 dols. per ton of productive capacity. It may well be doubted whether the British steel industry has in the immediate future as much to fear from the competition of the United States in the world's markets as from that of Germany, nor has it anything to fear from Germany if only it fully utilises its advantages and capabilities.

THE LIBRARY.

The following books have been presented to the Library since the last announcement:—

Archibald, R. D., B.Sc., and R. Rankin.—Electrical Laboratory Course for Junior Students. London: Blackie and Son, Ltd., 1908. Presented by the Publishers.

Beadle, Clayton.—Chapters on Papermaking. Vol. 5. London: Crosby Lockwood and Son, 1908. Presented by the Publishers.

Bloxam, W. Popplewell, B.Sc., F.C.S.—Report on Research Work on Indigo performed in the University of Leeds, 1905-7. Presented by the Secretary of State for India.

British Rainfall, 1907. Edited by H. R. Mill, D.Sc. London: E. Stanford, 1908. Presented by the Editor.

Canada Year Book, 1907. Ottawa: 1908. Presented by the High Commissioner for Canada.

Carotti, Dr. G.—A History of Art. Vol. 1.—Ancient Arabic Art. London: Duckworth and Co., 1908. Presented by the Publishers.

Clews, Henry, LL.D.—Fifty Years in Wall-street. New York: Irving Publishing Co., 1908. Presented by the Author.

Cochrane, J. Greig, M.A.—A Three-Term Course in German. London: Blackie and Son, Ltd., 1908. Presented by the Publishers.

Collings, Right Hon. Jesse, J.P., M.P.—Land Reform. New Edition. London: Longmans, Green and Co., 1908. Presented by the Publishers.

Day, Lewis F.—Nature and Ornament. Vol. 1. Nature the Raw Material of Design. London: B. T. Batsford, 1908. Presented by the Publisher.

Ewing, J. A., C.B., LL.D., F.R.S.—The Mechanical Production of Cold. Cambridge: University Press, 1908. Presented by the Syndics of the University Press.

Fisher, W. R., M.A.—Schlich's Manual of Forestry. Vol. 5. Forest Utilization. 2nd Edition. London: Bradbury, Agnew and Co., Limited, 1908. Presented by the Secretary of State for India.

Franklin Bi-centennial Celebration, Philadelphia, 1906. Calendar of the Franklin Papers. Vols. 2-6. Philadelphia, 1908. Presented by the American Philosophical Society.

Galloway, W., F.G.S. — Colliery Explosions and Rescue Work. London: Gresham Publishing Company, 1908. Presented by the Author.

Gregory, J. W., D.Sc., F.R.S.—Geography—Structural, Physical and Comparative. London: Blackie and Son, Limited, 1908. Presented by the Publishers.

Grierson, Walter. — Advanced Book-keeping. London: Blackie and Son, Limited, 1908. Presented by the Publishers.

Harrison, General Sir Richard, G.C.B.—Recollections of a Life in the British Army. London: Smith, Elder and Co., 1908. Presented by the Author.

India, Imperial Gazetteer of. New Edition, 24 vols. Oxford: University Press, 1908. Presented by the Secretary of State for India.

Jackson, F. Hamilton, R.B.A.—The Shores of the Adriatic. London; John Murray, 1908. Presented by the Publisher.

Johnstone, J. W. D.—Gwalior, 1905. London: J. and E. Bumpus, Ltd. Presented by the Secretary of State for India.

Lee, Elizabeth. — A School History of English Literature. Vol. 3. Pope to Burns. London; Blackie and Son, Ltd., 1908. Presented by the Publishers.

Leighton, Alex., M.A., B.Sc.—Intermediate Geometry. London: Blackie and Son, Ltd., 1908. Presented by the Publishers.

Lewis, C. T. Courtney.—George Baxter, his Life and Work. London: Sampson Low, Marston and Co., Ltd., 1908. Presented by the Publishers.

London Statistics. Vol. 18, 1907-8. Presented by the London County Council.

Malaya (British), Twentieth Century Impressions of. Edited by Arnold Wright. London: Lloyd's Greater Britain Publishing Co., Ltd., 1908. Presented by the Crown Agents for the Colonies.

Meyer, A.—Bedford High School Conversational German Grammar, 1st and 2nd years, 2 vols. London: Blackie and Son, Ltd., 1904 and 1907. Presented by the Publishers.

Millar, G. G.—What is a Picture? London: Elliot Stock, 1908. Presented by the Publisher.

Mole, Albert C.—Student's Epitome of Accountancy and Book-keeping. London: Walter Mole and Co., Ltd. 1908. Presented by the Publishers.

New South Wales Statistical Register for 1906 and previous years. Sydney: W. A. Gullick. 1908. Presented by the Agent-General for New South Wales.

Ogilvie, John, LL.D.—The Student's English Dictionary. Edited by Charles Annandale, M.A., LL.D. London: Blackie and Son, Ltd. 1908. Presented by the Publishers.

Reynolds-Ball, Eustace.—Mediterranean Winter Resorts. 6th edition. London: Hazell, Watson and Viney, Ltd. 1908. Presented by the Author.

Rowe, Eleanor.—Chip-Carving and other Surface Carving. London: B. T. Batsford. 1908. Presented by the Author.

Rye, Reginald A.—The Libraries of London—A Guide for Students. University of London, 1908. Presented by the Author.

Scott-Mitchell, Frederick.—Specifications for Decorators' Work. London: The Trade Papers Publishing Co., Ltd. 1908. Presented by the Publishers.

Stokes, Hugh.—The Art Treasures of London—Painting. London: Arnold Fairbanks and Co., Ltd. 1908. Presented by the Publishers.

Wadia, P. A., M.A.—The Philosophers and the French Revolution. Bombay: "Times of India" Office. 1908. Presented by the Publishers.

Wake, Reginald, and Eugen Brechtel.—Germany in Story and Song. London: Blackie and Son, Ltd. 1908. Presented by the Publishers.

Wardle, Sir Thomas, J.P.—Divisibility of Silk Fibre. Manchester: John Heywood, Ltd. 1908. Presented by the Author.

Watt, Sir George, C.I.E., LL.D.—The Commercial Products of India. London: John Murray. 1908. Presented by the Secretary of State for India.

Webb, M. de P., C.I.E.—India and the Empire: A Consideration of the Tariff Problem. London: Longmans, Green and Co. 1908. Presented by the Author.

Woods, H. C.—Washed by Four Seas. London: T. Fisher Unwin. 1908. Presented by the Author.

Wright, Herbert, A.R.C.S.—Hevea Brasiliensis, or Para Rubber. 3rd Edition. London: MacLaren and Sons. 1908. Presented by the Publishers.

GENERAL NOTES.

HOP CULTIVATION IN THE UNITED STATES.—It is not only in England that the hop grower finds it difficult to cultivate at a profit. Much is said about American competition, but the American grower seems to be no better off than the English. In his report on the agriculture of the States of Oregon, Washington, Idaho, and Montana (No. 4148, Annual Series), Mr. Consul Laidlaw refers to the hop crop in Oregon and Washington States. There were about 27,000 acres under hops in Oregon and fully 7,000 acres in Washington last year, but as it became evident that prices would not cover the cost of production, about one-third of the crop was left on the vines. The product of Oregon was, however, about 140,000 bales, and of Washington 32,000 bales. Hops in the bale cost the grower fully 4d. per lb., and but few were sold to cover this figure. The American experience of last year again demonstrates the instability of this crop. Growers on the Pacific Coast made an attempt to form an association for the purpose of controlling the production and marketing of hops, but it came to nothing. There is a substantial reduction of acreage this year, and many yards will not be cultivated. Had the whole crop of Oregon and Washington been picked in 1907 it would probably have yielded 225,000 bales, or 371,650 cwts.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

JANUARY 20.—"Gothic Art in Spain." By HENRY C. BREWER. MAJOR MARTIN HUME will preside.

JANUARY 27.—

FEBRUARY 3.—"The Problem of Unemployment." By BOLTON SMART (Superintendent of the Hollesley Bay Labour Colony, Suffolk).

FEBRUARY 10.—"Bosnia and Herzegovina." By ARCHIBALD R. COLQUHOUN, F.R.G.S., M.Inst.C.E.

FEBRUARY 17.—"The Commercial Relations of France and Great Britain." By MONSIEUR YVES GUYOT.

Dates to be hereafter announced:—

"Railway Development in China." By ARTHUR JOHN BARRY, M.Inst.C.E.

"The Application of the Microscope to the Study of Metals." By WALTER ROSENHAIN.

"The Resources of Peru." By C. REGINALD ENOCK, F.R.G.S.

"Afforestation and Timber Planting in Great Britain and Ireland." By. J NISBET.

"Destruction of Vermin." By JAMES CANTLIE, M.A., M.B., C.M., F.R.C.S., D.P.H.

"Hand-made Papers." By CLAYTON BEADLE and HENRY P. STEVENS, M.A., Ph.D.

"The Foundations of Stained Glass Work." By NOEL HEATON, B.Sc., F.C.S.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

JANUARY 28.—"Some Phases of Hinduism." By KRISHNA GOBINDA GUPTA, Member of the Council of India.

FEBRUARY 25.—"The Buddhist and Hindu Architecture of India." By ARTHUR ANTHONY MACDONELL, M.A., Ph.D., F.B.A., Boden Professor of Sanskrit, University of Oxford.

MARCH 25.—

APRIL 29.—"The Problem of Indian Labour Supply." By SELWYN HOWE FREMANTLE, I.C.S.

MAY 27.—"The Function of Schools of Art in India." By CECIL L. BURNS, Principal of the Bombay School of Art.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

FEBRUARY 2.—"The Production of Wheat in the British Empire." By ALBERT E. HUMPHRIES, Chairman of the Home-Grown Wheat Committee.

MARCH 16.—"The Colonial Wool Trade." By S. BANKS HOLLINGS.

APRIL 6.—"Ceylon: its Industries and Material Progress." By the Hon. JOHN FERGUSON, C.M.G.

MAY 4.—

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

G. L. ADDENBROOKE, M.I.E.E., "The Public Supply of Electric Power in the United Kingdom." Three Lectures.

LECTURE I.—JANUARY 18.—Statistics of the power employed in the United Kingdom—The opening for electrification—Public supply of power by local authorities and companies—The present position—Prices of power supply—Power used in proportion to labour—The influence of load and diversity factors — Capital cost of power supply undertakings.

LECTURE II.—JANUARY 25.—The working costs of power supply undertakings of different sizes and the prices at which they can supply energy—The modern power station.

LECTURE III.—FEBRUARY 1.—The distribution of electric energy at high pressure—Electric energy at the consumers—The development of electric power supply in the United Kingdom—Some observations on the legal position and on the relations of public and private enterprise.

LEON GASTER, A.M.I.E.E., "Methods of Artificial Illumination." Four Lectures.

February 15, 22, March 1, 8.

GEORGE GERALD STONEY, M.Inst.C.E., "Steam Turbines." Three Lectures.

March 22, 29, April 5.

F. W. LANCHESTER, "Aerial Flight." Three Lectures.

April 26, May 3, 10.

JUVENILE LECTURES.

CHARLES WALDSTEIN, Litt.D., Ph.D., Slade Professor of Fine Art in the University of Cambridge, "Digging for Ancient Art Treasures." Two Lectures.

LECTURE I.—JANUARY 6.—The excitement of the treasure-hunter—Uncertainty and mystery—Excavating combines all the elements of sport and excitement with higher and nobler spiritual aims—How ancient sites came to be buried—What the excavator might find in London two thousand years hence—Methods of excavating—Examples of prehistoric and Egyptian digging—The only records of prehistoric man out of which our knowledge concerning him is derived—Excavations of ancient Troy, Mycenae, Tiryns—Dr. Evans's work in Crete—Minos and the Cretan Labyrinth.

LECTURE II.—JANUARY 13.—Some of the lecturer's excavations—The tomb of Aristotle and its contents—The Argive Heraeum—Plataea—The great excavations of the Germans at Olympia and Pergamon—The French at Delphi—Specimens of beautiful works of Greek Art which the spade has restored to us—The future of excavation—Herculaneum.

The lectures will be fully illustrated by lantern slides taken during the excavations, and from the works of art recovered.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 4...Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Messrs. B. F. Howard and O. Quick, "Cinchonamine and Certain other Rare Alkaloids." 2. Messrs. W. P. Dreaper and A. Wilson, "Reactions between Dyes and Fibres." 3. Drs. S. B. Schryver and R. Lessing, "A Physico-Chemical Method for Comparing the Antiseptic Value of Disinfectants."

Victoria Institute (in the ROOMS OF THE ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.), 4½ p.m. Prof. Sir William M. Ramsay, "Life in a Country Town of Lycaonia." (Conditions of Christian Life under the Eastern Empire.)

Geographical, Burlington-gardens, W., 3½ p.m. (Juvenile Lecture.) Rev. T. T. Norgate, "In the Land of the Vendetta."

London Institution, Finsbury-circus, E.C., 4 p.m. (Juvenile Lecture.) Mr. F. Martin Duncan, "Romance of Animal Life in the Sea."

TUESDAY, JAN. 5...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Prof. W. Stirling, "The Wheel of Life." Lecture IV.—"Rivers of Life."

WEDNESDAY, JAN. 6...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. (Juvenile Lecture.) Prof. C. Waldstein, "Digging for Ancient Art Treasures." (Lecture I.)

London Institution, Finsbury-circus, E.C., 4 p.m. (Juvenile Lecture.) Mr. Martin Duncan, "Romance of Animal Life on Land."

THURSDAY, JAN. 7...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Prof. W. Stirling, "The Wheel of Life." Lecture V.—"Sentinels and Citadels."

FRIDAY, JAN. 8...London Institution, Finsbury-circus, E.C., 4 p.m. (Juvenile Lecture.) Mr. F. Martin Duncan, "Romance of Insect Life."

Architectural Association, 18, Tufton-street, S.W., 7½ p.m. Mr. H. D. Searle-Wood, "Building Materials."

Geographical, Burlington-gardens, W., 3½ p.m. Mr. E. P. Gaston, "Zig-zag Journeys in many Lands."

SATURDAY, JAN. 9...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Prof. W. Stirling, "The Wheel of Life." Lecture VI.—"Work, Fatigue, and Repose."

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FRIDAY, JANUARY 8, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, JANUARY 13th, 5 p.m. (Juvenile Lecture.) CHARLES WALDSTEIN, Litt.D., Ph.D., Slade Professor of Fine Art in the University of Cambridge, "Digging for Ancient Art Treasures." (Lecture II.)

Further particulars of the Society's meetings will be found at the end of this number.

PROCEEDINGS OF THE SOCIETY.

JUVENILE LECTURE.

On Wednesday afternoon, January 6th, Mr. CHARLES WALDSTEIN, Litt.D., Ph.D., Slade Professor of Fine Art in the University of Cambridge, delivered the first of two lectures addressed to a juvenile audience, on "Digging for Ancient Art Treasures."

SIR WILLIAM LEE-WARNER, K.C.S.I., who presided, introduced the lecturer.

After a sympathetic reference to the terrible disaster in Sicily which had devastated so many classic sites, Professor Waldstein asked his audience to consider what the excavator had to do. He enjoyed all the excitement of the treasure-hunter, the uncertainty and the mystery as to what he might find buried in the bowels of the earth, together with higher and nobler aims, and the knowledge that he was seeking the pure gold of truth. Since the discovery of Herculaneum and Pompeii great advances had been made in the science of excavation. Things were no longer left to chance, but were organised and systematised, and at the present moment excavations were being carried out all over Europe, with the result that, whereas some fifty years ago all knowledge of the development of the human race stopped at about 1100 B.C., classical archæology now knew much about life for some two thousand years preceding the historical period.

After illustrating the methods of excavators by asking his audience to imagine what might happen if the air-dwellers of 3900 A.D. should descend to dig in the ruins of London, Professor Waldstein proceeded to explain how, with the aid of geology and palæontology, we had been able to trace back the outlines of human development through the prehistoric to the dawn of historic periods. Having shown a number of slides of stone and flint implements illustrating the progress of man at various stages, the lecturer came to the more modern art treasures of Greece and Rome. If a man desired to discover some buried city, how, asked the lecturer, must he set about his task? In the first place he must read all the literature bearing upon the subject, so that he might be able to follow up any clue given by the writers of the past; and in the second place he must have an eye for the lie of the land, and be able to distinguish, as it were by instinct, artificial from natural irregularities in the ground. Professor Waldstein, with the aid of slides, then proceeded to show how with these guiding principles he had been able to locate the Heraeum, to uncover the whole site with *stoa*, gymnasium, stairs, and Roman baths; and how from the fragments of marble found there, the architect had been able to deduce the plan and style of the whole building. Perhaps the most notable of all the lecturer's discoveries, however, was a tomb which he found buried deep under great slabs of marble; it contained a figure carefully rolled in sheets of gold, a gold ring, seven diadems, a statuette of a philosopher, a pen, and styluses; and, from the inscription, he was led to believe, though some authorities doubted it, that this was the tomb of the philosopher, Aristotle.

A series of slides illustrative of the life led by Professor Waldstein as an excavator in Greece concluded the lecture.

CANTOR LECTURES.

TWENTY YEARS' PROGRESS IN EXPLOSIVES.*

By Oscar Guttmann, M.Inst.C.E., F.I.C., F.C.S.

Lecture III.—Delivered December 7, 1908.

In the year 1580, Michel Eyquem de Mon taigne, in his "Essais," wrote with reference to gunpowder:—"Except to astonish the ears, to which by now everybody is accustomed, I believe this is a weapon of very little effect, and I hope that we shall one day give up its use."† Would anyone have dared to repeat such a thought thirty years ago? Yet it has come true.

About the year 1410 we find that quaint treatise on gunpowder called "Feuerwerksbuch," said to have been written by a master gunner, Abraham von Memmingen. It contained the famous history of how Berthold Schwarz tried to make a gold paint and invented gunpowder and guns instead. This book was lent to other master gunners, who severally copied it, until in 1534 it was printed in Frankfort-on-the-Main, under the title of "Büchsenmeysterei." In this printed edition we find a prescription, "How to shoot out of a gun as far with water as with gunpowder": Take 6 parts of nitric acid, 2 parts of sulphuric acid, 3 parts of liquid ammonia and 2 parts of "oleum benedictum" (crude tar oil), and charge the gun to a tenth part of its bore. It further advises quaintly, "Light it quickly, so as to get away in time. See that the gun is strong. With an ordinary gun you can shoot three thousand paces with this water, but it is splendid." This is the first evidence of a nitrated organic substance having been used as a propellant.

I have already alluded to the history of the invention of gun-cotton, but one reference remains to be given, showing how early the use of gun-cotton in rifles was thought of. It is known that Schönbein reported on his gun-cotton on the 11th of March, 1846, and on the 27th of May, 1846, he made experiments with rifles. Professor Otto of Brunswick had, independently of Schönbein, also made gun-cotton, and published his results on the 5th of October, 1846. He also tried gun-cotton in a rifle, and Dr. Hartig, a Councillor of Forestry, together with Chief Forester von Schwarzkoppen, certified to have been present when experiments with a rifle and ball loading were made. This same Dr. Hartig published a pamphlet in 1847 at Brunswick under the title "Untersuchungen über den Bestand und die Wirkungen der explosiven Baumwolle" (Experiments on the condition and effects of explosive cotton), and therein he makes a statement, which has since attained great importance. He says that the effect which acetic ether has on "the shooting fibre" is very remarkable. He has found that if he makes a stiff, clear jelly with this ether from the shooting fibre, it does not alter its chemical state; and if put in a thin layer on a plate of glass, a snow-white residue is left after the ether has evaporated. If this residue is put into dilute alcohol and then dried, it will have in every respect the same properties as the shooting fibre. He mentions already that, probably on account of the altered state of aggregation, there is a considerable diminution of the explosive force.

Nothing was heard of a real powder made of nitrocellulose for a very long time. It is true that in 1847 the "Commission du Pyroxyle," which was appointed in France, "experimented with it in every form, as wadding, spun, twisted, woven, ***reduced to powder by the action of paper-makers' cylinders***, felted together by means of dextrine, finally ***granulated like cannon powder***;"* but it was too violent for use in guns and rifles. Baron von Lenck, in Austria, made gun charges from fibrous gun-cotton, and we know that they were not a success. In 1865 Captain Eduard Schultze, of Berlin, published a pamphlet on his "new chemical gunpowder," in which he gave the first indication of his powder, but more words than details. At the same time, however, a number of German journals published some particulars of its manufacture. According to them it was made from wood, which was formed into veneer, and a punching machine punched small discs therefrom. These wood discs were boiled with soda and washed, after that boiled with steam, again washed for 24 hours, then bleached with bleaching powder, washed again, and, after drying, nitrated in about the same way as collodion cotton is nitrated nowadays. After washing, the wood was boiled in soda solution, and, after further

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† "Sauf l'étonnement des aureilles, à quoy désormais chascun est apprivoisé, je crois que c'est une arme de fort eu d'effect, et espère que nous en quittons un jour l'usage."

* "Note sur la pyroxyline ou coton-poudre," par M. Susane. "Mémoires de l'académie impériale de Metz." 1855.

washing, soaked in a saturated solution of potassium nitrate and barium nitrate. Very soon after, Schultze used finely pulped nitro-cellulose, and made powder grains by agglomeration with water in drums. It is also remarkable that in 1865 Abel* patented the production of grains of gun-cotton by placing a mixture of gun-cotton with water and a little gum arabic in a pan and giving it a shaking motion, whereby the gun-cotton was formed into grains. He also proposed to mix soluble and insoluble gun-cotton, and to make the soluble gun-cotton serve as a binding material by treatment with wood spirit, alcohol, ether, or mixtures of these liquids. It is further interesting that Dr. Kellner, of Woolwich, is mentioned in a German book, which appeared in 1866,† to have been the first to succeed in making a granular smokeless powder. Neither Abel nor Kellner seem to have continued at the gelatinisation of nitrocellulose.

The author well remembers, however, a firm in Marchegg, near Vienna, which existed under the name of Volkmann's k.k. priv. Collodinfabriks Gesellschaft H. Pernice and Co. They originally bought the patent for the Schultze powder, and made it under the name of Nitroxylin. From 1872 to 1875 they made a powder called Collodin, the invention of Frederick Volkmann, which was patented under dates 8th November, 1870, and 31st May, 1871. After three years of existence the Austrian Government caused the works to be closed, because they claimed that this explosive was infringing their gunpowder monopoly. Thus this powder was lost to the world, and no information regarding it was procurable, until recently, when the author succeeded in obtaining a copy of these most remarkable patents.

Volkmann cut up alder wood into small grains of the size of black powder. He boiled them in a 3 per cent. soda solution, washed them, treated them with steam, and washed them again. He then bleached them in a solution of bleaching powder, and after final boiling with pure water, nitrated them in a mixture of nitric and sulphuric acids. Thus far the treatment was that usually given to cotton waste. The finished grains were soaked in a solution of potassium nitrate and barium nitrate, and after drying, treated with a mixture of 5 volumes of ether to 1 volume of alcohol. This was carried out in two different ways. The grains were either covered with ether-alcohol, left therein for between 3 and 30 minutes according to size, and taken out before the solvent had penetrated right through. They were then agitated by means of air, and also sprinkled with dry powder dust to prevent their sticking together, and subsequently dried. Alternatively, the solvent was allowed to penetrate the grains completely, and the more the substance dissolved the more the volume decreased. On taking the powder out of the solvent it had the appearance of a mush, which, after 12 hours' drying at 30°C., was converted into a dough, a pasty, pliable substance, from which any shape could be obtained by moulding and pressing. By dissolving or pressing to a greater or lesser extent the rapidity of combustion in rifles of these shaped bodies could be modified at will. He claimed finally that "the advantages of this powder over the chemical wood powder consist in its vapour being so transparent as not to prevent the eye from seeing the object on shooting in rapid succession; in having a lesser report; in leaving little dry, ash-like residue, which is washed away by the succeeding shot; in requiring half the weight of black powder in order to carry the projectile one-third further with a quarter greater muzzle velocity; in having half as much again a straighter trajectory; in having an uniform effect, inasmuch as it is not a mechanical mixture; in being unattended by danger in manufacture, storage, and carriage; in its being undamaged by moisture; in its volume being considerably reduced in relation to its density, whereby it can be used even for rifles, having a very small chamber for the charge; and in its being more economical for blasting purposes." Truly Volkmann seems to have known everything about a smokeless powder.

Patents at that time were kept secret in Austria, and thus the method of manufacturing this powder was not known to the world at large.

In 1882, Mr. Walter F. Reid patented* the agglomeration of nitrocellulose into grains and moistening them with ether-alcohol for the purpose of hardening the grains. I had the advantage of seeing this manufacture, and some experiments with this powder, in 1883, in which year also Oscar Wolff and Max von Foerster published and patented† the method of coating small cubes of gun-

* British Patent, No. 1102, of 1865.

† "Buch der Erfindungen," Leipsic, 1866, chapter on gunpowder and arms.

* British Patent, No. 619, of 1882.

† British Patent, No. 3866, of 1883.

cotton with a solvent for the purpose of keeping them permanently moist. Mr. Reid's powder is manufactured under the name of E.C. powder, and is still a favourite sporting powder; but being what is now called a bulk powder, namely a powder of very loose structure and low volumetric density, it was too violent in its effects for military rifles, whilst for sporting rifles it was just the right thing. I would again mention here that in the beginning of 1886 I suggested to Professor Hebler, the well-known Swiss pioneer of the small-bore rifle, the use of a piece of blasting gelatine as a charge for a rifle cartridge,* but that the very idea frightened him, although he wished to have a pellet of compressed gun-cotton from me for the purpose. All these tentative experiments were eclipsed by the invention of Vieille in 1886,† who thoroughly gelatinised nitrocellulose and made sheets of it, which he cut up in strips or small lozenge-like squares. It has been said that Vieille made his discovery whilst trying to make a bulk powder similar to E.C. powder; but I have it from him that his invention was the outcome of prolonged study and experiment to determine the effect of increased loading density on the rate of combustion, leading him to increase gradually the solvent action until he obtained a thoroughly gelatinised powder.

This impartial survey shows that while the merit of making the first powder-like material from a nitro-compound belongs to Hartig, and whilst Schultze made the first commercial powder, yet the invention of a gelatinised powder in the modern sense must be attributed to Friedrich Volkmann, although, independently of him, Reid re-discovered 12 years later a sporting powder, and Vieille, 16 years later, a thoroughly gelatinised military powder. It appears, therefore, that the Austrians were not only the first to experiment with gun-cotton in guns, but had the present-day smokeless powder before others, only to crush it out of existence by their monopoly. The clock of industrial progress was thereby virtually put back 15 years.

The division of smokeless powders into those that are made of nitrocellulose alone and those that are made with nitrocellulose and some other nitro-compound, might nowadays well be reduced to nitrocellulose powders and nitro-cellulose-nitroglycerine powders. All other smokeless powders had a comparatively short life, and were not introduced into the service of any army. Nitroglycerine-nitrocellulose powder was invented by Alfred Nobel in 1888,* who gave it the name of Ballistite. The British Government adopted a powder which contained insoluble gun-cotton with nitroglycerine and vaseline, the whole being dissolved in acetone.† Nobel at first used for his Ballistite soluble nitrocellulose with nitroglycerine and camphor, but the latter ingredient was afterwards discarded. Ballistite is the Service powder in Italy, and is much used for large guns. Aniline is now added, and it is claimed both for vaseline, aniline and diphenylamine that they exert a great stabilising influence on the powder.

There is no need for me to detail the manufacture of powders. This is a subject of great mechanical interest, and although the shape and the physical condition of the powder has a considerable influence on its shooting qualities, yet it is not intended to include the machinery in the present lectures. Nitrocellulose powders are made from dry nitrocellulose in a mixing machine, using a solvent (generally ether-alcohol or ether-acetone). In many factories the nitrocellulose is made anhydrous by soaking it in alcohol, first of all in alcohol that has been used for this purpose, and then in pure alcohol, squeezing it out every time in a press. Some think that the quality of the powder is affected by this method, whilst it is more probable that certain unstable compounds, or such as could affect the regularity of shooting, would be eliminated by the alcohol treatment. Some have found a loss of substance up to 5 per cent. to take place with certain nitro-cottons. The mixture is then rolled under a pair of heavy rolls into sheets of the required thickness, which are cut up into squares, and afterwards dried. In some Services ribbons are used instead of grains, and in others threads or tubes are made of such powder and cut into sticks of the length required for the charge. In Germany camphor was formerly added to the powder whilst kneading it. Some countries leave a certain amount of the solvent in the powder; and formerly in France a little amyl alcohol was added, while now diphenylamine has been adopted: this was already used in 1889 in Germany for C/89 powder made by the Cologne-Rottweil factory. The threads of powder, generally squeezed out of a dye by hydraulic pressure, are frequently hung up on clips in drying cupboards, or else

* "Journal of the Society of Chemical Industry," 1894, p. 575.

† "Mémorial des poudres et salpêtres," 1890, p. 9.

* British patent, No. 1471, of 1888.

† British patent, No. 5614, of 1889.

cut up into sticks and dried on trays, thus giving a good opportunity for recovering the solvent. Flake powder and stick powder are frequently boiled in water to free them from solvent; nitroglycerine powders like cordite undergo much the same treatment as pure nitrocellulose powders.

Ballistite is made in a different way. Soluble nitrocellulose in the shape of a fine powder is suspended in 15 times its own bulk of water, and nitroglycerine added, the mixture being stirred by means of compressed air. This causes the nitroglycerine to dissolve up the nitrocellulose, the water acting as a carrier only. This process is the invention of Messrs. Lundholm and Sayers,* and has enabled as much as equal weights of nitroglycerine and nitrocellulose to be incorporated. The paste resulting in this way is freed from water in a centrifugal machine and allowed to ripen. It is then brought under steam-heated rolls, weighted to exert a pressure of 100 atmospheres to incorporate it thoroughly, and then mixed by rolling the sheets over and over until they are quite satisfactory. The sheets so obtained are then cut up into flakes, cubes, strips, &c., as required. Another powder made in Italy is Solenite, which consists of 30 parts of nitroglycerine, 40 parts of insoluble and 30 parts of soluble nitrocellulose, the two having an average of 12·6 per cent. nitrogen. Acetone is added for promoting the solution of the insoluble nitrocellulose. This is an outline of the manufacture only, and it would not be right to give further details here.

I ought to say a good deal regarding the various forms in which powders are made nowadays, but I could hardly do that without going more fully into the machinery required to give them these forms. You will readily understand that every weapon may, and generally does, require a different powder in order to give the desired velocity and not to exceed the permissible limits of pressure. It is obvious that it would be very easy to alter the composition in every case; but, as a matter of course, such an expedient would be quite undesirable, alike from a manufacturing and from a Service point of view. Hence, already in the days of black powder, it has been the custom to vary the shape and size of the powder. We thus have ribbons in France, strings in Great Britain, flakes and tubes in Germany, cords of square section in Italy, short multiperforated cylinders in the United States, cubes from ballistite, spiral sporting powder in Germany, the poudre peigne (spiral powder with comb-shaped incisions) of French inventors, &c. Further, these powders may then be made in various lengths, breadths, or thicknesses, and with various kinds of holes, incisions, &c. It is quite impossible to generalise, and to say that a particular form is good or bad, because it probably does suit a special weapon. It is a fact that up to a certain size round grains are most likely to give good combustion, and that cord or tube come next; on the other hand, a flat ribbon is likely to burn more uniformly, although again a variation in the rate of combustion at different intervals of time may just be what is wanted.

The conviction grew of late that in addition to being smokeless a powder should also be flameless, so as not to disclose the position of an attacking force. Smokeless powder does show a very strong luminous flame, chiefly on account of its high temperature of explosion, which causes the particles of residue to become incandescent, and also owing to the fact that some of the powder charge always escapes combustion in the gun and follows the projectile as a luminous tail for a short distance. The problem being somewhat similar to that presented by explosives in coal mines, it is not surprising that one of the first patents in this connection, that of Duttenhofer,* proposes to add sodium bi-carbonate to the powder, a substance which has the effect of cooling the flame by losing its water of crystallization and carbon dioxide. Other substances like oils, soaps, &c., are employed, but the matter is not yet in a sufficiently advanced state to permit of an opinion being expressed.

Varying circumstances underlying the manufacture of these smokeless powders combine to affect their quality. The military powders suffer in the first instance from irregular shooting. This is of course due to defective composition, be it *ab initio* on account of the selection of unsuitable proportions, or of bad or careless manufacture. With military powders, the compositions and methods of manufacture are laid down in accordance with experience and tests, but this introduces the danger of too narrow limits, with the result that everything goes wrong, when there is the slightest variation in, say, the nitrocellulose or the thickness of the powder. In the case of sporting powder, it is necessary to carry out shooting tests with every small batch, because the reputation of a firm depends on keeping out of the market powder which is in the slightest degree

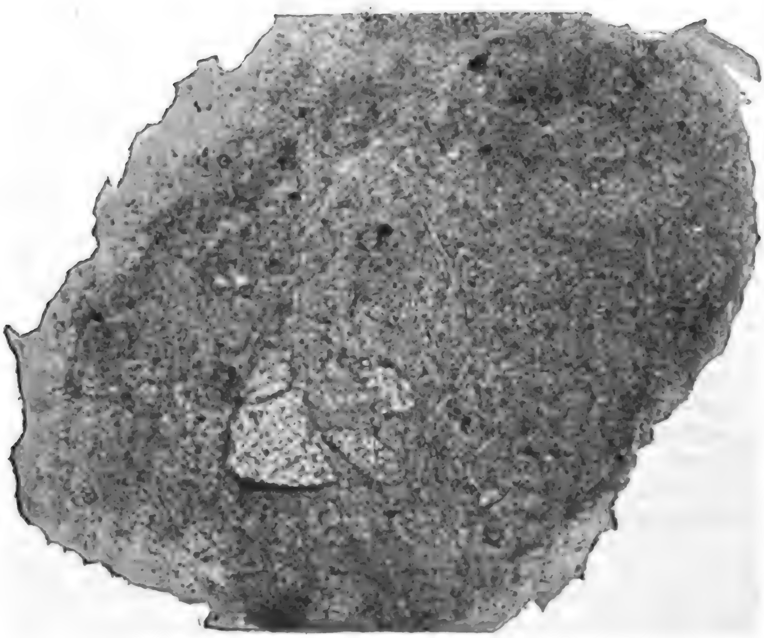
* British Patent, No. 10376, of 1889.

* British patents, Nos. 19408, of 1906, and 791 of 1907.

deficient. Careful blending has to be resorted to in order to obtain absolutely uniform results throughout.

Of other difficulties in manufacture I will mention only a few. The treatment of a powder under rolls is to a certain extent arbitrary. It is all very well to look through the paste; the sheet may appear quite transparent to a good and experienced eye, yet small nodules of nitrocellulose may have escaped solution for a long time. The constant crackling heard when rolling thin sheets plainly points to such isolated and undissolved fibres. Incorporating in a kneading machine does not improve matters, more especially as these machines are really poor mixers, although some knead very well. Pressing powder out of a die gives very good results with small diameters; but with larger diameters very much depends upon the shape of, and the wear on, the nozzle, its position among several others or relatively to the die, and on whether the outer skin will contain air bubbles or be cracked. If too much solvent is taken, or the proportions of a composite solvent are not quite suitable, the density and uniformity of the powder will suffer. One of the greatest difficulties lies in the proper drying of a powder. The smaller sizes of sticks, ribbons, tubes, &c., are easier to deal with, although they also would seem to require more attention than simply to leave them for a certain length of time in a stove. The larger and thicker ones, however, sometimes require months to dry properly, and it may then be found that the outside of, say, a half-inch cylinder is full of fine hair cracks, whilst the inside is still comparatively soft. With some powders this defect is to a certain extent avoided by leaving some of the solvent behind; but then, of course, we have on the one hand the difficulty of not knowing exactly when the correct amount of solvent is present, and, on the other hand, a certain amount of risk, in that the powder would in course of time undergo changes by gradual evaporation of the solvent.

FIG. 5.



SMOKELESS BULK POWDER. (Seen under the Microscope in Ordinary Light.)

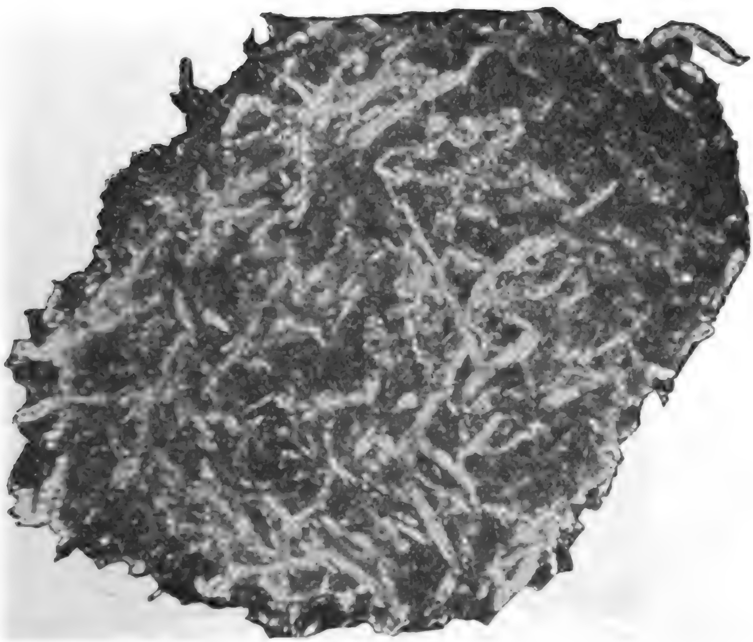
I have already stated that, as far as military powders are concerned, there are nowadays only two varieties—pure nitrocellulose powders, and those made of nitrocellulose and nitroglycerine. Formerly all kinds of powders were made, some of very fanciful mixture; but it was found that complicated compositions were most difficult to regulate, and a return was therefore made to more simple combinations.

I need not enter into these, every book and *The Patent Journal* will satisfy the curious. Sporting powders are of two kinds—the so-called bulk powders, consisting of loose granules coated or hardened by means of a solvent, and the so-called condensed powders, which are gelatinised throughout, and made in practically the same way as military flake powders.* The former are supposed exactly to fill a cartridge used in the old black powder gun, the latter are made for more modern weapons. Another kind of sporting powder, which occupies an intermediate position, is made on the lines of the Walsrode powder, one of the earlier explosives, which still holds the market. This powder is thoroughly gelatinised, but then treated with water or steam, whereby granules are formed and part of the solvent is driven out again, leaving a "bulky" but hard-grained powder behind. The usual "bulk" powders are composed of soluble nitro-cotton mixed with potassium or barium nitrate, and generally worked up in an incorporating mill or drum. The mixture is then either sprinkled with water in a rotating drum so as to form grains, or extended on a shaking table making short and rapid oscillations. Alternately it may be put into an hydraulic press, and then broken into grains, the solvent being in every case sprinkled over when the grains are already formed.

The "condensed" powders are usually made by rolling the "paste" into very thin sheets (0·1 mm. and less), which are then cut into small flakes to obtain the requisite rapidity of combustion. Such powders are dried fairly quickly, and they may sometimes even be boiled in water to promote elimination of the solvent.

The properties, keeping qualities, advantages and defects of smokeless powders and explosives generally, I will refer to in my last lecture.

FIG. 6.



SMOKELESS BULK POWDER. (Seen under the Microscope in Polarized Light.)

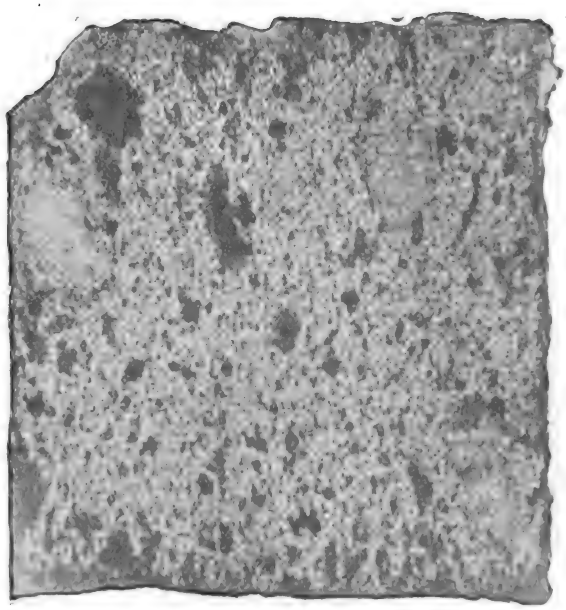
Since 1800, when Howard invented fulminate of mercury, and since 1815, when Joseph Egg made the first cap, but little progress has been made in the manufacture of these articles. It is still the usual cap and the usual detonator, the only difference being that potassium chlorate enters partly into the composition of detonators; whilst for smokeless powders a hotter flame is found essential, and is obtained by adding a combustible substance. The idea of metallic powders also had an influence upon cap compositions, aluminium powder, either mixed with the fulminate or pressed in a layer

* The microphotographs 5, 6, 7 and 8 were kindly prepared by Mr. Henry de Mosenthal.

above it, having been successfully employed by Dr. Brownsdon and the King's Norton Metal Company.* Quite recently Wöhler and Matter made fulminates the subject of an interesting piece of research,† and found that small quantities of silver nitride suffice to replace the fulminate. Bielefeldt found already in 1900‡ that a small quantity of fulminate placed on top of trinitrotoluene or other aromatic nitro-compound forms an excellent detonating mixture. It is said that quite half of all the detonators at present manufactured in Germany are made with larger scale than formerly. Two kinds of mixers are used, both practically identical, inasmuch as mixing is effected by the gentle motion of indiarubber bodies, and both very safe to handle. The English mixer is called the jellybag mixer on account of a silk bag containing indiarubber rings strung up; the German mixer is saucer-shaped and contains indiarubber balls.

The increasing demand for ammonium nitrate safety explosives has resulted in the use of greater quantities of powerful detonators. In the days of Kieselguhr dynamite a

FIG. 7.



SMOKELESS FLAKE POWDER. (Seen under the Microscope in Ordinary Light.)

trinitrotoluol. Hyronimus§ proposes lead nitride ($[N_3]_2$ Pb) as a substitute for mercury fulminate.

The manufacture of fulminate of mercury is carried on in almost the same way as that described fifty years ago. Its colour has, however, been improved from grey to white by the addition of a little hydrochloric acid and copper to the acid mixture, and the alcohol is now recovered from the carefully condensed vapours. The mixing of cap composition has to be carried out on a much

* British Patent, No. 23366, of 1904.

† "Zeitschrift für das gesamte Schiess-und-Sprengstoffwesen," 1907, p. 181. Also British Patent, No. 4468, of 1908.

‡ British Patent, No. 20133, of 1900.

§ British Patent, No. 1819, of 1908.

No. 3 detonator was usual, and a so-called "double-force" (No. 5) detonator was quite a luxury. Nowadays nearly all safety explosives require a No. 6 detonator, and most manufacturers would be only too glad if the miner could be persuaded to use a No. 8 (2 gram) detonator, so as to make quite sure of perfect explosion. For the same reason, great progress has been made with electric detonators. Formerly high-tension fuses fired by frictional electric machines were almost solely used, and Breguets were the only low tension fuses employed in mines. Nowadays the tendency is to use low tension fuses and magneto firing apparatus, thus greatly reducing the risk of firing the pit gases. Last year

the Fabrik Elektrischer Zünder, in Cologne, tried a system of shot firing from the surface. Formerly only a comparatively short length of wire could be laid without unduly increasing the strength of current required, and the man firing the shot had to take shelter in the mine. This firm introduces relays at various intervals, which keep up the strength of the current, so that a permanent main cable can be laid right up to the pit's mouth. When everybody has left the mine the shots are fired, and ample time is thus given for any hang-fires to go off.

Bickford's invention still holds the field as regards safety fuses. I have explained in my first lecture wherein the few improvements consist, that were made on safety fuses. It is curious that all attempts to make a safety fuse with a core of smokeless powder or some other nitro-compound, have so far been unsatisfactory. It seems impossible to ensure uninterrupted burning. The Westphälisch Anhaltische Gesellschaft some years ago made a fuse of this kind, which was not supposed to fire pit gas,* and was intended for use in fiery mines. It was, however, evidently in its initial stage when I tested it, and I have not heard of it since. Of late rapid-burning fuses were introduced, some being fired in groups by means of pistols and other central firing arrangements. General Lauer and Mr. Tirmann introduced friction fuses, which are fired by means of wires from a distance, and are extensively used, chiefly in Austrian coal mines. Girard made "cordeaux détonants" by filling lead tubes with nitrohydrocellulose, and then drawing them out to the diameter of ordinary safety fuse. In 1906 these fuses were filled with melinite and now trinitrotoluene is also used, which permits the employment of lead tubes instead of the costly tin tubes indispensable with a picric acid explosive.* The most perfect fuse of this kind is, however, the instantaneous fuse invented by General Hess, and introduced into the Austro-Hungarian service. Originally it consisted of a mercuric fulminate core on four threads. In 1903 Hess "phlegmatised" the fulminate† by the addition of 20 per cent. of hard paraffin, but a number of such fuses, tied together by knots, can be detonated by a common detonator, thus replacing electric shot firing and dispensing with a detonator in each borehole. The fuse can be cut, hammered, squeezed, &c., without danger. Quite 13 years ago, I could not understand why private manufacturers had not commenced to

FIG. 8.

SMOKELESS FLAKE POWDER. (Seen under the Microscope in Polarized Light.)

* British patent, No. 2225, of 1898.

* Artilleristische Monatshefte, August, 1908.

† "Mittheilungen über Gegenstände des Artillerie und Geniewesens," 1907, p. 115.

manufacture Hess' fuses for use in mines, and more especially with safety explosives, for which purpose they were readily adaptable. The "phlegmatised" fuse is a great improvement, and I can therefore emphatically repeat my recommendation.

The more industry progressed all over the world the greater the coal consumption became, and the more frequently occurred those appalling mine disasters which from time to time convulse public feeling. The British Government was the first to nominate a Fire-damp Commission; but this only recommended a palliative measure in the shape of a water cartridge. Then followed Commissions in Prussia, France, Saxony, and Austria; but not one of them tried a safety explosive before September, 1885. The Prussian Commission at their meeting on the 25th of June, 1886, permitted by 13 votes to 10 the use of dynamite when less than 3 per cent. of gas was present. The Commission even failed to ignite air containing between 3 and 10 per cent. of pit gas by means of guncotton. Tonite was found unsafe; compressed Schultze powder was safe in a 10 per cent. gas mixture, but it was considered liable to decompose and to be very hygroscopic. The Prussian Government, however, had built a testing station and trial gallery at Neunkirchen in the beginning of September, 1885, under the direction of Mr. Margraf, who tested Hellhoffite, made by Messrs. Schmidt and Bichel, and consisting of nitric acid and nitrobenzene. Although this proved safe in the usual pit gas mixtures, yet it was found impossible to manipulate it, so another explosive—"Carbonite"—made by the same firm, was tried. This was safe in small charges only; improvements were therefore made, and, in September 1887, a Carbonite consisting of saltpetre, cellulose, nitroglycerine and sulphuretted oil was found to be absolutely safe. In 1886 Margraf tested Securite (dinitronaphthalene and ammonium nitrate mixed with an alcoholic solution of nitrated resin) against Carbonite, and this also was found safe. In April, 1887, Roburite and Kinetite were tried, and in August, 1887, soda dynamite. Thus Carbonite was really the first safety explosive, and, curiously enough, it has not yet been surpassed for safety.

It is necessary to distinguish between explosives which are safe in manipulation (handhabungssicher), and such as are safe in fire-damp (wettersicher). The latter only are called safety explosives in this country, and I cannot understand why it was resolved at the Congress of Applied Chemistry in Rome to designate by the word safety explosive those safe in manipulation only, when 25 years of usage clearly pointed to another meaning. At any rate, even those who proposed this resolution have since been unable to bring it into effect.

The obvious question is, what makes an explosive safe in fire-damp? I confess that, having most carefully examined the views of those most competent to give an opinion, I fail to find a definite answer. At one time the Prussian Commission stated that the more rapid the explosion the safer the explosive, and some colour is lent to this theory by the fact that fulminate of mercury does not ordinarily ignite fire-damp, whilst black powder always does. The theory is, however, controverted by certain black powder mixtures, foremost among which is Bobbinite, which is safe up to a certain point, and by nitroglycerine and blasting gelatine which are not.

The French Government Commission stated that a mixture of methane and air would ignite at 650° C, but that ignition was delayed for about ten seconds, and therefore a so much higher temperature was necessary that an explosive, whose temperature of explosion as calculated by thermochemical data was below 1500° C, could be licensed for use in fiery mines. Curiously enough, Carbonite, so far the safest of all, and several others which are licensed for such use, have a temperature of explosion considerably higher than 1500° C.

Mr. Bichel, to whom in conjunction with his collaborator Dr. Mettegang, we owe most excellent methods for examining explosives, says that the velocity of detonation, the maximum temperature of the products of combustion, the length and the duration of the flame of an explosive, all influence the safety of an explosive adversely.* Whilst this is undoubtedly correct, he has thereby abandoned the theories of others, and this perhaps advantageously. Thus he requires a slow detonating explosive, and does not trouble about the temperature of explosion, but about the temperature of the products; the length and duration of the flame are evidently a function of the rapidity of explosion and the quantity of its products. He therefore considers, and in the author's opinion very justly, the nature of the products of combustion to be all important, whether they

* Glückauf, 1904, No. 35.

consist of solid particles which remain incandescent for a considerable time, or of large quantities of combustible gases shot forward with great force. In this way he corroborates early attempts to photograph the flame of an explosion made by Schoeneweg, the inventor of Securite, and by Siersch of Pozsony. He does this by placing the whole matter on a scientific basis, using ingenious apparatus for determining each factor. The velocity of detonation cannot, however, be considered to be a determining factor under all circumstances. Certain nitroglycerine explosives, amongst which we may also include Carbonite, explode much more rapidly than, say Bobbinite, and yet show themselves to be much safer when tested. I myself have found that up to a certain point the addition of picric acid gave increased safety on test.

It will be remembered that the British Commission found a water-jacket round the charge very efficient. In Austria they followed this up by using wet moss and sand, and thus the idea of using water of crystallisation instead was evolved. Sodium carbonate, magnesium sulphate, and other substances were tried, either separately in front of the explosive or as ingredients. More prominence was then given to the French recommendations, and the notion became prevalent that the addition to the explosive must be a flame-cooling agent in the shape of water vapour or some other heat-absorbing gas. Thus permanganate, bichromate, oxalates, and other salts were used, and of late common salt has sprung into favour.

The only definite result obtained so far is that ammonium nitrate is absolutely safe in all quantities, and that the addition of cellulose to nitroglycerine compositions, *e.g.*, rye flour to Carbonites, or wood pulp to other explosives, renders them highly inert in fire-damp mixtures. Ammonium nitrate cannot, however, be used by itself, although Lobry de Bruyn succeeded in exploding it,* and, therefore, some combustible substance must be added. It simply remains to be determined what minimum quantity of such combustible can be added to avoid flames of great length and duration.

The next question is how can one tell whether an explosive is "safe." This question is a still more difficult one to answer. The various Governments, and also certain factories, have erected testing stations in which explosives are tested in mixtures of air with natural pit gas, artificially produced methane, coal gas, benzene, &c. I myself have had the privilege of designing a testing station of this kind for a German factory. These stations generally consist of a long wooden or iron tunnel, round or oval in section. The explosive is shot at a definite angle with the roof out of a mortar into a gas mixture, thus imitating the natural conditions in a mine as closely as possible. In some of these stations a short section may be partitioned off for special tests. In this country a ballistic pendulum is used to ascertain the quantity of the explosive equal in force to four ounces of dynamite No. 1, and this quantity with a stemmed shot is then fired in air containing 15 per cent. of coal gas. If the mixture does not fire in 20 shots, the explosive is considered a safe one. In most other countries the quantity of the explosive in question is determined, which will fire and that which will just not fire a certain pit gas mixture. This gives us what Mr. Watteyne, the well-known Belgian authority, calls the "charge limite" of an explosive. This latter way is certainly the more rational one, since it permits of comparison between different kinds of explosives. Is this method of testing, however, above reproach? I think not, although I know of no better one at present. It has been found that the narrower the bore of the cannon the more easily ignition takes place under certain circumstances. The Woolwich circular section gallery, which has a sectional area of 0·36 square metres, is much more sensitive than the elliptical Belgian one, whose sectional area is 2 square metres, and in fact even with equal diameters each gallery may be said to have its own ignition temperament, which affects the results. Thus, quite recent tests at Frameries in a gallery having a sectional area of 0·28 square metres showed that two safety explosives, whose *charge limite* was 900 and 450 grammes respectively, fired at 300 and at 75 grammes. The gas used also exerts considerable influence on the tests, and it is a great pity that the proposal made at the Berlin Congress of applied chemistry to carry out comparative tests between certain gas mixtures was not adopted.

It has been known for a long time that coal dust as well as pit gas is highly explosive, and in the early days of safety explosives tests were made in coal dust alone and in coal dust mixed with pit gas. I believe that Engler, when investigating explosions in the charcoal heaps of the Black Forest,* was the first to

* "Recueil des travaux chimiques des Pays-Bas," 1891, p. 127.

* "Chemische Industrie," 1885, No. 6.

show that mixtures of air with coal and other carbonaceous matter which, on heating, develop combustible gases, could be exploded, but that this was not the case with charcoal or soot. Mixtures of coal gas and air, however, so poor in gas as to be non-inflammable, were rendered explosive by the addition of some charcoal dust. Other experts, such as Mr. Simon, of Liévin,* have carried out and described many experiments with coal dust, whilst Messrs. Martin and Hall, the British Inspectors of Mines, have preached in vain against dusty roads. Ultimately, when mere watering of mine galleries proved to be of little use, the Mining Association of Great Britain took the lead, experimentally investigating the influence of coal dust on explosions in mines. As is usual, anything done in this country is done thoroughly, and an iron shell, 7 feet 6 inches in diameter, and 1,083 feet long, was used to

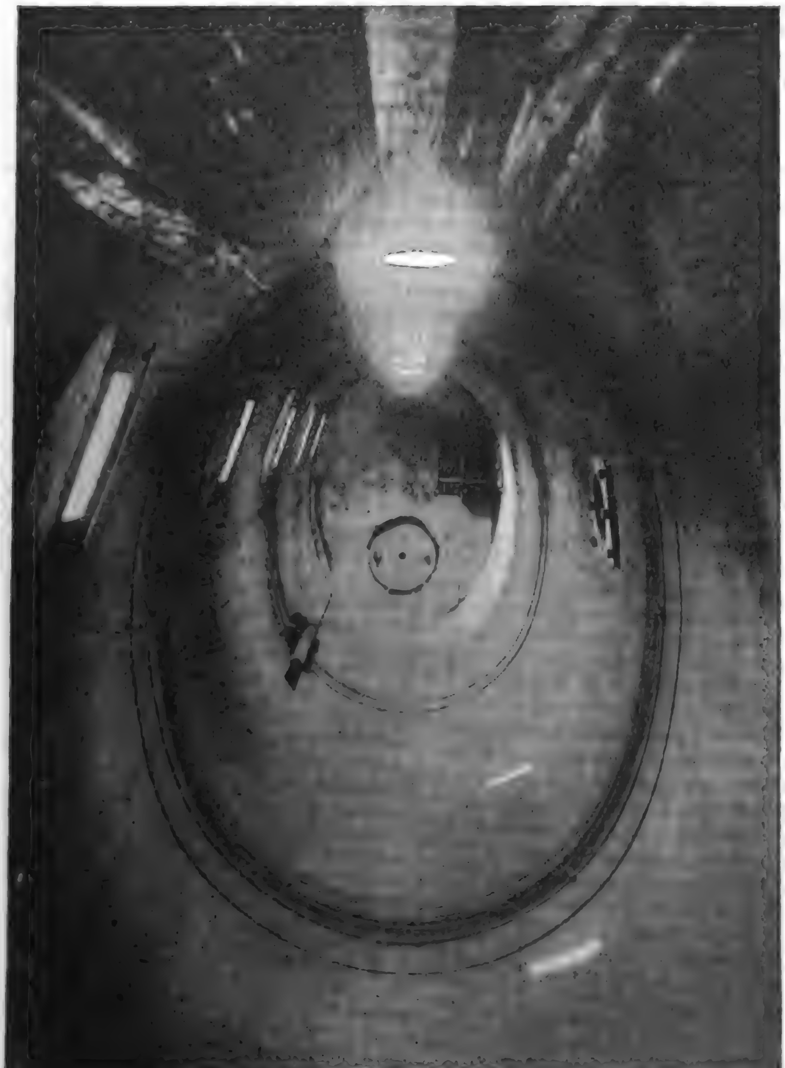
FIG. 9.

TESTING STATION AT FRAMERIES. (End view.)

* "Annales des Mines," November, 1890.

carry out the experiments. So far, it has already been ascertained* that two zones of stone dust on either side of a zone of coal dust arrested the path of a flame, and that unless the coal dust zone exceeded 180 feet in length, no explosive force was manifested. Might I methods for absorption has proved to be the production of a fine spray, or mist of moisture. It seems quite feasible to utilise certain lengths of tunnel for the construction of inverted absorption towers at intervals, and certainly at every point where a side gallery runs into the

FIG. 10.



TESTING STATION AT FRAMERIES. (View of the Interior.)

submit an old idea, which I base on some patents of mine that have proved highly useful. An absorption tower retains solid particles contained in a gas mixture, and also cools the latter very efficiently, and one of the best

main or haulage roads. Water is plentiful in a mine, high pressure pumps are always available, and it would therefore only be necessary to instal and maintain a number of spray nozzles, like those used for absorbing and cooling steam in large generating plants, to permeate an air zone, say 20 yards long, with

* "Coal Dust Experiments," *The Times*, September 24th, 1908.

fine water mist. I think a number of such zones would absolutely prevent the ever present danger of transmitting an isolated explosion to the whole of the mine, whilst it will cause no inconvenience, and may even beneficially affect the miners. I hope this idea will be given a trial in the near future. So much seems certain to me from the study of the results of past investigators that a small addition of coal dust will be found to promote the explosion of poor gas mixtures, and that, therefore, a separation of the dust from the gas will, in some cases, prevent an explosion.

Lacking definite knowledge as to what renders an explosive safe in fire-damp, and how this is to be ascertained, it would be natural to seek a solution in practical results. The sale of an article does not always depend upon its real value, but very frequently on the way in which it is advertised and pushed, whether it is made in the country of consumption or not, whether it possesses disadvantages that render another less efficient article a preferable one, &c. In spite of this, it is not unfair to assume that the statistics showing the quantities of safety explosives actually consumed in a great coal-producing country like Great Britain have a real bearing on the question as to which explosives have given a reasonable amount of safety. The report of the Inspectors of Explosives for 1907 gives the following highly-instructive table.

Out of a total consumption of 7,764,122 lbs. were used :—

Name of Explosive.	Quantity Used. lbs.		Percentage of Total.
Saxonite	1,721,193	..	22·18
Bobbinite	1,063,111	..	13·69
Monobel Powder	711,691	..	9·17
Ammonite	562,405	..	7·25
Carbonite	551,948	..	7·11
Roburite	510,438	..	6·57
Arkite	437,780	..	5·64
Westfalite	405,691	..	5·22
Bellite	371,455	..	4·78
Rippite	306,408	..	3·95
Faversham Powder	224,200	..	2·88
Stowite	180,393	..	2·32
Ammonal	114,806	..	1·48

Of these Saxonite, Monobel powder, Carbonite, Arkite, Rippite, and Stowite contain large percentages of nitroglycerine. Bobbinite is a black powder mixture, the rest are ammonium nitrate explosives.

From the enquiry on Bobbinite* the following table regarding accidents in coal mines caused by various safety explosives in 1904 and 1905 is calculated :—

	Bobbinite.		Other Permitted Explosives.	
	No.	Per cent.	No.	Per cent.
Consumption in 1907	—	13·69	—	86·31
Accidents	20	17·54	94	82·46
Killed	2	8·33	22	91·67
Injured	30	18·87	129	81·13

It will thus be seen that a black powder mixture like Bobbinite, which would not be licensed in any other country and be condemned without trial, ranks second in consumption, being used to the extent of 13·7 per cent. of the total consumption; whilst Saxonite, a nitroglycerine explosive, ranks first with 22·18 per cent. of the total.

Am I therefore right in saying that we have succeeded in making the use of explosives in coal mines infinitely more safe than before, but that we do not really know why ?

* Report of the Departmental Committee on Bobbinite, London, 1907.

PATENTS REVOKED AND COMPULSORY WORKING UNDER THE NEW ACT.

By J. A. Law, C.P.A.

The Comptroller-General (Sir C. N. Dalton) has just issued the second decision under the section of the Patents and Designs Act of 1907 enabling a patent to be revoked on the ground of failure to carry out the patented manufacture to an adequate extent in this country. The first decision was noticed in an article by the writer in *The Manchester Guardian* of the 12th December, 1908, and has been fully reported in the London papers. It dealt chiefly with the question whether the patentee had given satisfactory reasons for not carrying on the manufacture as required by the Act. The decision just given deals also with the question of the extent of manufacture in this country that can be regarded as adequate.

The invention in question related to sewing-machines and consisted of a number of improvements and special constructions of parts of a machine, the main object of the invention being, according to the complete specification, to produce a lock-stitch sewing-machine capable of operating at a very high speed with smoothness, ease, and but little noise, upon either thick or thin material. It appears that the machine was imported from the United States wholly manufactured, but that before it was sold in this country a few parts were taken out and for them there were substituted others which were manufactured here of strength and of design specially suited to the intended purpose of the machine. The substituted parts were, however, very few in number as compared with the other patented parts of the machine. Certain

accessories not the subject of the patent were manufactured in this country and sold in certain cases with the machine.

The Comptroller, as no doubt was to be expected, said that the accessories must be disregarded, as they did not form part of the invention protected by the patent.

In regard to the parts of the patented article that were made in this country, the Comptroller held that, on the facts of the case, the patented article was not manufactured to an adequate extent in the United Kingdom within the meaning of the section. The Comptroller added, "It seems to me impossible to contend that the public demand in this country for the patented article is substantially made by the manufacture here of a comparatively small number of substantial parts which are mere modifications, made to suit the taste and convenience of certain purchasers, for which there would be no demand except for the purpose of using them as parts of the entire machine."

It is not very clear how far this decision goes, but it is submitted that it is not distinctly laid down that in order to carry out adequate manufacture it is necessary to manufacture in this country the whole of the parts of a machine when only certain parts, or combination of parts, of that machine are claimed by the patentee as his invention. It is true that the passage above quoted seems rather to indicate that the entire machine should be manufactured in this country, but in arriving at the principle on which to decide what was adequate manufacture, the Comptroller referred to decisions of the Supreme Court of the German Empire, which he considered, although they might not be binding on English Courts, could not be lightly disregarded by him in the absence of decisions of the English Courts to the contrary, and he came to the conclusion that if the essential features of a patented article were not manufactured in the United Kingdom to such an extent as substantially to satisfy the demand here, but were imported from the United States, the patented article was not manufactured to an adequate extent in the United Kingdom. According to one of the decisions apparently referred to by the Comptroller, when an invention consists merely in the combination of known parts it is sufficient to make the combination in Germany, and the making of the individual parts is not necessary. When, however, an alteration of known parts is necessary to bring about the effect of the combination, the alteration at least, according to the German law, must be effected in that country. From this it would appear that if the German practice is to be followed it would be sufficient in the case of a patent for a combination of parts merely to put together the parts in this country, provided that the parts are such as are ordinarily made for other purposes, and are not, therefore, necessarily made for the purpose of the invention. It does not seem improbable, however, that the amount of manufacture required in any particular case will depend upon the wording of the claims of the patent in question.

The decision also deals with the question of whether the patentees had given satisfactory reasons why the patented article was not manufactured to an adequate extent in this country. The patentees admitted that they had the machines manufactured for them in the United States by a firm whom they alleged to be the best tool manufacturers in the world and declared that, regard being had to the nature of the tools and the skilled workmanship required, it would be absolutely impossible to manufacture successfully in the United Kingdom entire sewing-machines according to the patent. The Comptroller said that, although it was very natural that the patentees should, in perfect good faith, believe that their machine was a better one than any one else could produce and that the American firm were the best tool manufacturers in the world, it was manifest that opinions of that kind must be received with considerable hesitation in view of the high-class machinery that was turned out in this country and on the Continent, and that, even if they should be substantiated, they could not of themselves afford a satisfactory reason for not manufacturing in the United Kingdom, since, even if they were correct, they would not explain why the patentee had not taken steps to import into this country the requisite tools and skilled labour for the manufacture of the machines.

In a further attempt to prevent revocation, the patentees alleged that if the patent were revoked the country would be flooded with German and other Continental imitations of their machines, which, they were convinced, were very much inferior to theirs. The Comptroller said that he could not but think that the persons who were likely to buy these machines, which he understood were not employed for domestic purposes, but mainly by large wholesale firms making ready-made clothing, might be safely trusted to look after their own interests in the matter, and he doubted very much whether they would not prefer that the trade should be freed, and that they should have the opportunity of testing the qualities of some of those much maligned German sewing-machines, which could not be brought into this country as long as the patent remainded in force.

In regard to whether he should make an order revoking the patent forthwith, or after a reasonable interval specified in the order, the Comptroller said that he thought the power to defer the revocation for a reasonable interval was given for the protection of patentees who of their own accord had taken substantial preliminary steps—for example, by the purchase of sites and the erection of factories—to comply with the requirements of the Act, but had not had sufficient time to complete their works and actually manufacture the patented article before the application had been made to revoke their patent. In the present case it appeared that the patentees had taken no steps whatever with a view to meeting the require-

ments of the section, although more than sixteen months had elapsed since the passing of the Act.

In the result, the Comptroller ordered, subject to an appeal to the Court, that the patents should be revoked forthwith, and that the patentees should pay the applicants' costs to the amount of forty guineas.

HOME INDUSTRIES.

The Proposed Engineering Amalgamation.—A proposal for a great engineering amalgamation is being considered, and there can be little doubt that if it goes through it will greatly benefit the engineering industry on the North - East Coast. It will include several very large engine-building firms, and enable the shipbuilding industry to be supplied with machinery at prices which will compare favourably with those of other competing centres, whilst securing a fair manufacturing profit. Marine engine building presents an ideal proposition for the application of such a scheme. At the ordinary general meeting of Richardson, Westgarth and Co., Ltd., one of the concerns to be included in the proposed amalgamation, Sir Christopher Furness drew a graphic picture of the havoc wrought by the senseless strike, which involved the practical stoppage of the engineering industry on the North-East Coast for some months of last year. "We were compelled," said Sir Christopher Furness, "to see our profits turned into losses, grass actually growing in our yards, our customers disappointed and dispirited, and our business brought to a dead standstill, by reason of our inability to accept orders." The strike is over, but much of the mischief caused by it remains. Foreign rivals have got a start that will be difficult to recover. The position to be faced is one of intense competition,—how intense is indicated by the fact that once highly remunerative forge departments are now practically closed, as forgings can be obtained at considerably lower prices than they can be produced in this country. If this great industry is to be restored to its former prosperity, or something approaching it, the excellence of manufacture must be increased and the cost of production decreased, results that might be greatly facilitated by amalgamation. The production of marine machinery, and the mass of detail in particular connection therewith, involves so many trades, each requiring a separate department, that specialised production in bulk, under concentrated management, becomes practically impossible for the average engine builder, but under an adequate scheme of amalgamation the entire proposition is simplified. For example, the companies considering the proposed scheme of amalgamation have, during the past seven years, supplied complete equipment to 1,206 steamships, having an aggregate horse-power of 2,150,000. The detail alone in connection with the yearly output of 172 sets of machinery is enormous, and were it standardised and manufactured under modern conditions profits would be obtained which, under the present conditions, are quite impossible. Experience has proved that in order to exist at all every engine manufacturer must, no matter how well his works may be equipped at present, continue to spend money very freely, and the essence of the contemplated scheme of amalgamation is to spend the money in such a manner as will enable a united body of manufacturers to meet competition with far greater success than is possible by independent units, each repeating the other's work in a fashion which, in years to come, will be regarded as tantamount to commercial suicide.

The Navy and Shipbuilding.—Although only a few shipyards and a few engineers have the necessary plant and experience necessary for Admiralty work, wherever the vessels are built a good deal of the accessory and incidental work, such as armour plates, electric machinery, steering gear, anchors and chains, guns and gun-mountings, &c., has to be done in other quarters, and the allocation of this work benefits the localities concerned. Recently considerable Admiralty contracts have been given out, the Clyde getting the lion's share, as was to be expected, seeing that the Clyde yards can supply every class of work that the Admiralty requires. Three second-class cruisers and two destroyers have been ordered from the Clyde, involving an expenditure there of £1,250,000, in addition to £600,000 for six destroyers ordered a short time previously. Three cruisers, eight destroyers, and the machinery for another of the cruisers are to be built on the Clyde, and the Fairfield Shipbuilding and Engineering Company are also to supply the turbines for the battleship *Bellerophon* now being completed at Portsmouth, whilst John Brown and Co., Clydebank, supplied the turbines for the cruiser *Boadicea* now being completed at Pembroke. The total money value of the contracts placed with the Clyde is about £2,500,000, and on the Tyne the battleship *Superb* is being completed by the Armstrong-Whitworth Company, and a 33 knot destroyer and cruiser have been ordered. Palmer's Company are building three torpedo boats and a destroyer, and the Parsons Turbine Company are making the turbines for a battleship building at one of the dockyards. The total money value of the Admiralty work now in hand on the Tyne is about £1,500,000. At Barrow, Vicars, Sons and Maxim have on hand a battleship and a number of submarines, besides a cruiser, and on the Mersey, Cammell, Laird and Co. have four destroyers. The total money value involved in the Admiralty contracts in the West Coast district is about £1,250,000. The Thames Ironwork Company, Thorneycroft and Co., and J. F. White and Co. have contracts for torpedo boats and destroyers involving an aggregate expenditure of about £1,250,000. It will be seen from these particulars that some of the yards and engine shops are being provided by the Admiralty with partial employment until the demand for merchant steamers revives.

The Training of Artisans.—Mr. J. W. Mahin, Nottingham, has addressed to the Department

Commerce and Labour at Washington an interesting memorandum upon the lack of a proper system of training for boys from 14 to 20 years of age for the engineering trades; and he attributes the large amount of casual labour and unemployment in this county to the facts that in relatively few factories boys are engaged as apprentices, and that in such factories where they are taken the employers are harassed and obstructed by the trade unions. The complaint is not a novel one, but the danger indicated is a very real one, and unfortunately the remedy is not apparent. It is much less easy than it used to be for aspiring youths to learn, by a thorough apprenticeship in the shops, to become skilled artisans. The system that reared a race of artisans and craftsmen unequalled in European commercial history is slowly passing away, and in its place we have the unsystematic employment of boys in workshops to learn what they can without the necessary drill, discipline, and progress from one job to another which make the capable workman. Mr. Mahin directs attention to the apprenticeship system in vogue in the works of Browne and Sharpe, of Providence, Rhode Island, where apprentices are taken through all the different departments of the works and are taught by special instructors. The managers of the firm say that the system is essential to the prosperity of the business, and that the upper ranks of the staff are recruited in this manner. There are of course firms in this country which depend for their future staff upon specially training boys in their own shops, but those who provide in this manner for the needs of special trades steadily diminish.

Japanese Competition.—Many fears have been expressed as to the effects of Japanese competition upon the British export trade, the argument being that this country will be greatly handicapped in the markets of the East by the products of the cheap labour of Japan. But the report of a United States special agent, who has been conducting investigations in Japan, goes to confirm the view that cheap labour does not necessarily mean cheap production. The agent in question says that a visit to Japan tends to disprove this theory. The Japanese in many directions, especially in cabinetmaking, is an expert and finished workman. Although he uses an infinitesimal plane, and planes towards himself, and his hand-saw looks like an over-grown butcher's knife, with saw teeth cut in its edge, he produces fine work. But give him a machine nearly automatic to tackle, and he is not a success. Wire nails are used exclusively in Japan, and hence there is an immense demand for them. Among the many stock companies formed during the Japanese - Russian War, when money was plentiful, was a wire nail mill. The latest up-to-date machinery was brought out from the United States, and everything that money and skill could command was secured to make the mill a great success. As a final step a superintendent was brought from a large mill from Cleveland, Ohio, and put in charge. In spite of this expenditure of talent, money, and time, the superintendent is not able to make nails at a price that at all interferes with importing and selling at a satisfactory profit. When asked why he cannot make nails as cheaply as he did in Cleveland, he replied, "It is simply a question of labour. In Cleveland one man tended and kept running four or five machines; here it takes four or five men to tend one machine, and they don't keep it running as they should at that."

CORRESPONDENCE.

THE WORKING OF THE PATENTS' ACT.

Referring to the remarks in this week's *Journal* may I venture to suggest that the "Working of the Patents' Act" which secured the revocation of the Belgian rights would cancel those of *any* other importing Patentee, which was, I assume, the object of the Act, and the incidence of ordinary competition was not within its scope. With regard to the English trade at large the revocation permits them to compete in the home markets, which they could not do before. Of course the cancellation of a foreign patent and the retention of the British rights would be advantageous; but is it practicable?

CHAS. ELSTOB.

January 2, 1909.

OBITUARY.

SIR THOMAS WARDLE, J.P., F.C.S., F.G.S.—The Royal Society of Arts has lost a well-known member in the person of Sir Thomas Wardle, who died at his residence, Leek, Staffordshire, on the 3rd inst., in his seventy-eighth year. Entering commercial life at an early age, he carried on a most successful business as silk dyer and finisher and a silk and calico printer. He was the first business man to discover a satisfactory process of dyeing the wild *tussur* silk of India, and, at the instance of Sir George Birdwood, he was sent out by the Secretary of State for India, in 1885, to report on sericiculture in Bengal. This was the first of several visits to the East, and in his work, "Kashmir and its New Silk Industry" (1904), Sir Thomas Wardle gave an account of the manner in which, mainly through his instrumentality, the moribund industry was, after innumerable difficulties, placed upon a footing of greater prosperity than it had ever enjoyed before.

Sir Thomas (who was appointed a Chevalier of the Legion of Honour for his services as a juror at the International Paris Exhibition of 1878-9, and received his knighthood in 1897) wrote numerous monographs upon the technical aspects of sericiculture and silk-weaving; and he was the honorary expert on silk of the Imperial Institute, president of the Silk Associa-

tion of Great Britain and Ireland, and hon. secretary of the Ladies' National Silk Association. He had many interests outside his immediate field of labour. He was a Fellow of the Chemical, Geological, and Royal Statistical Societies, and a member of the Council of the Palæontographical Society.

He became a member of the Society of Arts in 1878. In the following year he read his first paper on "The Wild Silks of India, principally Tussur," for which he received the Society's silver medal. Since then he contributed three papers, on "Researches on Silk Fibre," "The History and Description of the Growing Uses of Tussur Silk," and "Improvements in the Design, Colouring, and Manufacture of British Silks." On several occasions he presided at Ordinary Meetings of the Society, and he frequently made valuable contributions to the discussions.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

JANUARY 20.—"Gothic Art in Spain." By HENRY C. BREWER. MAJOR MARTIN HUME will preside.

JANUARY 27.—"The Part played by Vermin in the Spread of Disease." By JAMES CANTLIE, M.A., M.B., C.M., F.R.C.S., D.P.H.

FEBRUARY 3.—"The Problem of Unemployment." By BOLTON SMART (Superintendent of the Hollesley Bay Labour Colony, Suffolk).

FEBRUARY 10.—"Bosnia and Herzegovina." By ARCHIBALD R. COLQUHOUN, F.R.G.S., M.Inst.C.E.

FEBRUARY 17.—"The Commercial Relations of France and Great Britain." By MONSIEUR YVES GUYOT. SIR ROBERT GIFFEN, K.C.B., F.R.S., LL.D., will preside.

INDIAN SECTION.

Thursday afternoon, at 4.30 o'clock:—

JANUARY 28.—"Some Phases of Hinduism." By KRISHNA GOBINDA GUPTA, Member of the Council of India.

COLONIAL SECTION.

Tuesday afternoon, at 4.30 o'clock:—

FEBRUARY 2.—"The Production of Wheat in the British Empire." By ALBERT E. HUMPHRIES, Chairman of the Home-Grown Wheat Committee.

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

G. L. ADDENBROOKE, M.I.E.E., "The Public Supply of Electric Power in the United Kingdom." Three Lectures.

LECTURE I.—JANUARY 18.—Statistics of the power employed in the United Kingdom—The opening for electrification—Public supply of power by local authorities and companies—The present position—Prices of power supply—Power used in proportion to labour—The influence of load and diversity factors — Capital cost of power supply undertakings.

LECTURE II.—JANUARY 25.—The working costs of power supply undertakings of different sizes and the prices at which they can supply energy—The modern power station.

LECTURE III.—FEBRUARY 1.—The distribution of electric energy at high pressure—Electric energy at the consumers—The development of electric power supply in the United Kingdom—Some observations on the legal position and on the relations of public and private enterprise.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 11...Mechanical Engineers, Storey's-gate, S.W., 8 p.m. (Graduate Section.) Mr. Roy V. Vining, "Motor-Car Construction and Design."

Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on Mr. Herbert T. Scoble's paper, "The Administrative Aspects of Sewage Disposal."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. J. S. Scarf, "Light and Colour."

TUESDAY, JAN 12...Asiatic, 22, Albemarle-street, W., 4 p.m. Dr. A. K. Coomaraswamy, "Mahayana Bronzes from Ceylon and Java."

Photographic, 66, Russell-square, W.C., 8 p.m.

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8 p.m. Prof. R. Wallace, "Rhodesia and its Agricultural Possibilites."

WEDNESDAY, JAN. 13..ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. (Juvenile Lecture.) Prof. C. Waldstein, "Digging for Ancient Art Treasures." (Lecture II.)

Geological, Burlington-house, W., 8 p.m. 1. Prof. Johan H. L. Vogt, "Labradorite-Norite with Porphyritic Labradorite-Crystals: a Contribution to the Study of the 'Gabbroidal Eutecticum.'" 2. Mrs. Jane Longstaff, "The Genus *Loxonema*, with descriptions of New Proterozoic Species."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Discussion on "The Purification of Water by Ozone and other Chemical Substances." To be opened by Dr. S. Rideal.

THURSDAY, JAN. 14...Antiquaries, Burlington-house, W. 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. Arthur W. Hill, "The genus *Nototriche*, Turcz." 2. Dr. Percy Groom, "The Longitudinal Symmetry of Centrospermeæ."

Junior Engineers, at Royal United Service Institution, Whitehall, S.W., 7½ p.m. Professor John T. Nicholson, "The Laws of Heat Transmission in Steam Boilers, as deduced from Experiment."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. W. Rothenstein, "A Basis for the Appreciation of Works of Art."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Mr. Stanley Clegg, "The G B. System from a Tramway Manager's Point of View."

FRIDAY, JAN. 15...Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. Mr. John Don, "The Filtration and Purification of Water for Public Supply."

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FRIDAY, JANUARY 15, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, JANUARY 18th, 8 p.m. (Cantor Lecture.) G. L. ADDENBROOKE, M.I.E.E., "The Public Supply of Electric Power in the United Kingdom." (Lecture I.)

WEDNESDAY, JANUARY 20th, 8 p.m. (Ordinary Meeting.) HENRY C. BREWER, "Gothic Art in Spain."

Further particulars of the Society's meetings will be found at the end of this number.

SWINEY PRIZE.

The adjudicators under the will of the late Dr. Swiney are summoned to meet at the house of the Royal Society of Arts, John-street, Adelphi, London, on Wednesday, January 20, 1909, at 4.30 p.m., to make the award in conformity with the terms of the bequest contained in the will of the testator.

(By Order)
HENRY TRUEMAN WOOD,
Secretary.

POSTPONEMENT OF THE NEXT MEETING OF THE INDIAN SECTION.

Owing to the indisposition of Mr. Krishna Gobinda Gupta, who was to have read a paper on "Some Phases of Hinduism" before the Indian Section on January 28th, it has been found necessary to postpone the meeting to a date which will be announced subsequently.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1s. 6d. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

JUVENILE LECTURE.

On Wednesday afternoon, January 13th, Mr. CHARLES WALDSTEIN, Litt.D., Ph.D., Slade Professor of Fine Art in the University of Cambridge, delivered the second and final lecture of his course addressed to a juvenile audience, on "Digging for Ancient Art Treasures."

After briefly recapitulating the matter of his first lecture, Professor Waldstein proceeded to show a series of slides illustrating the excavations of Professor Flinders Petrie at Abydos. Egypt, the lecturer explained, was specially fruitful to the archæologist: both climate and soil were favourable to the preservation of archæological remains, and the result was that the spade had revealed traces of almost continuous human history for eighty centuries. Pictures were shown of vases whose probable date was 8000 B.C.; of jewellery from the grave of a queen, and a lady's false "front" of 5000 B.C.; of the Pharaoh who ruled Egypt in the time of the Exodus, and of a huntsman, surrounded by birds and beasts, and accompanied by a cat retrieving a bird for its master.

Professor Waldstein then spoke of the great work of Heinrich Schliemann, the poor boy of Mecklenburg, who, while apprenticed to a grocer, found time to make himself acquainted with the literature of Greece, and conceived a great ambition to excavate the site of Troy. The lecturer paid a warm tribute to this German pioneer, and explained how, in spite of the greatest difficulties and the adverse criticisms of many archæologists, he had succeeded in laying bare the site of Troy, and in tracing its history from pre-Homeric times to its occupation by the Romans. Many photographs were also shown of Dr. Schliemann's work at Mycenæ, where he discovered the palace of far-ruling Agamemnon, with its famous lion gateway, and the tomb of the monarch himself.

The work of Dr. Arthur Evans at Knossos, in Crete, was next described. Here had been found the palace of Minos, his labyrinth, his throne-room, and his throne, while in leaden boxes in a cellar were unearthed some clay tablets written in a script that has not yet been deciphered, but which appears to indicate that the Phœnician is not, as has been generally supposed, the earliest alphabet. Prof. Waldstein then passed to the French excavations at Delphi, which have been so successful that with the aid of Pausanias one may now wander over the site and recognise almost every building in the town. He also showed pictures of the great theatre at Epidaurus whose acoustic properties are so marvellous that, although it seats 10,000 people, the slightest whisper on the stage may be heard from the farthest benches. In conclusion, the lecturer expressed the hope that it might be found possible at no distant date to explore the site of the ancient Herculaneum on which the modern town of Resina has been built. From the few excavations made there in the eighteenth century there was every reason to believe that under the sea of mud which buried the ancient city lay the very richest treasures of classical art and literature.

The CHAIRMAN (Sir William Lee-Warner, K.C.S.I.) proposed a cordial vote of thanks to the lecturer for his interesting course, and this was carried unanimously.

CANTOR LECTURE.

TWENTY YEARS' PROGRESS IN EXPLOSIVES.*

By OSCAR GUTTMANN, M.Inst.C.E., F.I.C., F.C.S.

Lecture IV.—Delivered December 14, 1908.

There are still a few applications of explosives to be mentioned, and after that we may pass on to more general considerations.

Nitrocellulose has found a great sphere of use for purposes other than smokeless powder or dynamites. The celluloid industry, introduced by the brothers Hyatt, and more recently the artificial silk industry, consume enormous quantities. Of celluloid, the United States produce about 4,000 tons per annum, Germany 15,000, and the rest of the world about 5,000 tons, of which yearly total of 24,000 tons, this country produces about two per cent. This necessitates about 36,000 tons of nitrocellulose per annum. Of artificial silk, about 5,000 tons are made annually, though only about 200 tons in England. The amounts used for varnishes like Pegamoid, Fabrikoid, &c,. for making or steeping incandescent gas mantles, for waterproofing solutions, for patent leather (nitrocellulose dissolved in amyl acetate, and mixed with aniline black) and for photography, are also considerable. As already mentioned, all these industries have abandoned the use of anything but cotton, because the ultimate product was much more reliable, and at the same time possessed valuable properties, necessarily absent in nitrocellulose made from wood-pulp, paper, &c. This is especially the case with artificial silk, for which tenacity and ductility of the spun fibre are as important as viscous, yet easy issue from the orifice of the "silk worm." The solubility of the nitrocellulose in a definite mixture of ether-alcohol to the extent of 2 per cent. either way is by no means unimportant, as this may mean 10 per cent. more of very expensive solvent. When you consider that one of these factories, which I had occasion to revisit quite recently, makes as much as 3,000 kilogrammes of silk a day, you will have some idea of the sums involved.

The nitrocellulose for all these industries should be perfectly soluble in ether-alcohol, or, in the case of varnishes, in methyl-alcohol. Of course, perfection cannot be reached industrially, and although this is not so important in the case of celluloid, yet, with artificial silk and varnishes, special means have to be employed for filtering the solutions clear of undissolved fibre. It is also necessary to avoid turbidity on drying, this being frequently due to moisture.

In neither of these cases is the nitrocellulose pulped, but the whole fibre is dissolved. I am afraid purification is sometimes not carried as far as it ought to be, with due regard to the stability of the finished celluloid. In the case of artificial silk, the fact that the nitrocellulose is denitrated seems to indicate that thorough purification is unnecessary, but the silk fibre made from well stabilised nitrocellulose will be found to possess good properties of its own. The same may be said of varnish, although, in this case, a slight acidity at certain stages of the process has the advantage of rendering the nitrocellulose more readily soluble. This has also been shown in the investigations of Lunge and Suter.

The manufacture of these nitrocelluloses also varies in other respects. In dealing with such

large quantities, everything is carried out expeditiously and without much handling. Thus the acids are measured and not weighed, which is quite as accurate a method. The nitrated cotton is sometimes squeezed out by hydraulic pressure, and the waste acid runs through iron gutters to a huge tank, into which a stream of mixed acid flows at the same time. The flow is so regulated, with regard to the duration of each operation, that the composition of the acid mixture remains fairly constant, and gives a fairly uniform product. The nitrocellulose for artificial silk is not fully dried, but from 12 to 30 per cent. of water is allowed to remain in it; some patentees claim special advantages, and even a special chemical reaction for variations of five per cent. of water either way.

The further stages in the manufacture of artificial silk, namely, solution, filtration, spinning, denitration, conditioning, &c., have practically no bearing on explosives, and will not be further dwelt upon.

For the sake of completeness, mention must be made of the proposed use of explosives for motive power. I well remember having shewn me at Vienna, in 1878, an engine to be worked by small charges of dynamite. In order to show the absence of danger, the inventor had made the model entirely in wood. Again, quite recently, my advice was sought regarding the application of smokeless powder to flying machines. Descending to actual practice, Shaw's pile drivers, worked by gunpowder, are historical, and the rivetting machine of Bender,* using smokeless powder charges, certainly worked, though I do not know whether it was a commercial success. Several patents referring to motors and compressors driven by explosives have been taken out, and one of them quite recently.†

An account of the progress of explosives would be incomplete without mention of the conditions under which they are manufactured.

Anyone who, like myself, has occasion to see explosives factories in divers states of efficiency, can readily picture the state of small works at a time when regulations and inspections did not exist. Large works had too many interests at stake, and therefore always took some precautions, although of course not to the same extent as at the present time. The late Colonel Sir Vivian Dering Majendie deserves lasting recognition for having created that most excellent Explosives Act of 1875. Engineer-General Hess, when still Captain, was, with Captain Trauzl, instrumental in procuring the carriage of dynamite on the Austrian railways, and shortly afterwards he proposed, and in 1877 carried through, an Explosives Ordinance, which is practically identical with the British Act. The influence of this Act, and perhaps almost to the same extent of the annual reports of the British Inspectors of Explosives on the arrangements and construction of buildings and machinery, the general cleanliness of the operations performed, and the security of workmen against accident can hardly be overrated, and the example set in this country has been followed all over the world.

In arranging buildings, due consideration is now paid to the dangers present, on account of the nature of the operation and the quantity of materials dealt with. The advent of high explosives has, unfortunately, made us acquainted with effects of explosions unknown in the old powder days, and in order to counteract these effects the author recently suggested* the construction of danger buildings in a special kind of ferro-concrete. The buildings are so designed that pieces of burning *débris* cannot penetrate their roofs, and so bring about their destruction. At the same time the shock of the explosion transmitted from a distance through the ground will not cause the walls to open out. This proposal has been very favourably received by a number of manufacturers, and in several instances has already been adopted. The armouring of such a building forms a Faraday's cage and renders the whole structure lightning proof. This is of importance, since the regulations governing the erection of lightning conductors have not increased the safety of buildings to any great extent, in spite of lightning rod conferences and investigations. Magazines, which were satisfactorily tested on the very day of a thunderstorm, have been blown up, and nothing short of a cage, or at least a complete system of conducting network over and on the buildings, seems to be efficacious.

The construction of the mounds surrounding these buildings seems also to be influenced by a change of ideas. The old plan of erecting stone parapets is again coming into favour. The author recently observed the effects of an explosion in a dynamite building, which was

* British Patent, No. 26801, of 1898.

† British Patents, No. 961 of 1874, 24742 of 1904, 28376 of 1904, 22125 of 1905.

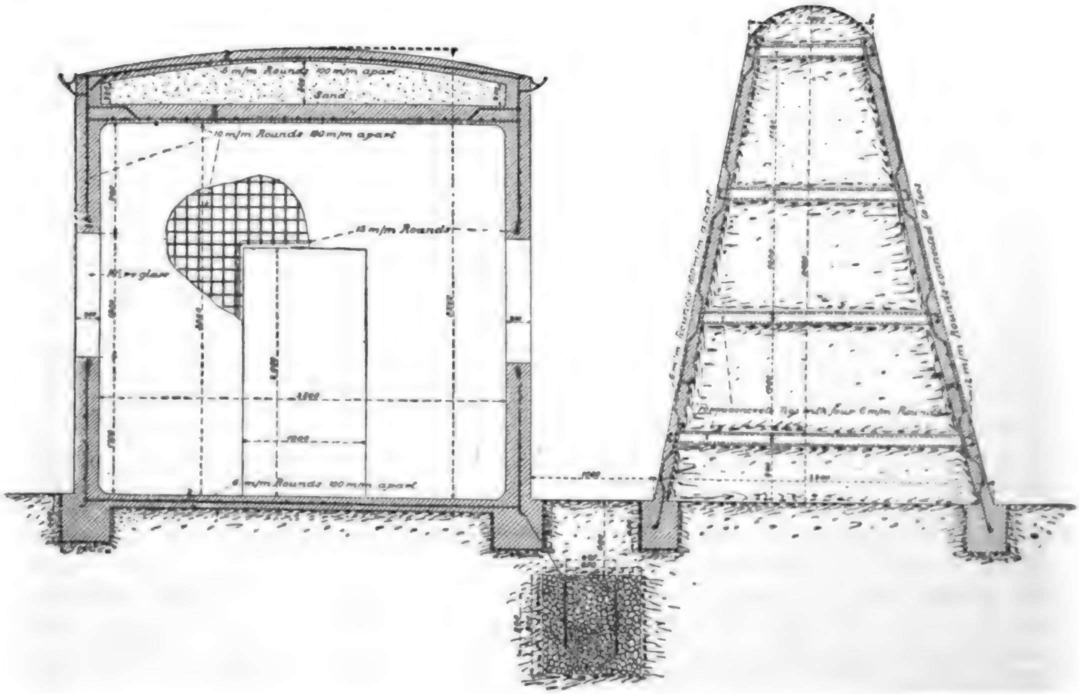
* "Explosions and the building of Explosives Works."—*Journal of the Society of Chemical Industry*, 1908, No. 13.

surrounded by solid stone walls. The wall on one side only was cracked, the rest remained untouched. The communication tunnels were also massively built in stone, and were quite undamaged. This proves the author's oft repeated objection to wooden tunnels, which collapse and take fire, to be a valid one. On the other hand, the author has seen sand mounds which appeared to have been lifted up by the shock from an explosion in another building, and to have spread out like putty on falling down again.

Despite all precautions, disasters of great magnitude will occur in modern explosives works. This is no doubt, in the first place, due to the fact that quantities are nowadays made in such works, which were not dreamt of 30 years ago. Thus, for instance, the works at Modderfontein and Somerset West produce annually over 10,000 tons of dynamite each, and several other works run them very close. Such an enormous output requires a considerable number of buildings, and consequently the chance of damage to life and property is greatly increased. The construction of factories has, on the other hand, proceeded on somewhat orthodox lines, and not always perhaps with due regard to subdividing and minimising risks. Thus, the great explosion at Avigliana assumed such enormous proportions because a piece of *débris* from a small building was projected into a magazine several hundred yards away, which latter, exploding in turn, threw *débris* into a number of other buildings. The explosion at Dömitz gave rise to precisely similar effects.

Another reason for such catastrophes is the want of appreciation of certain inherent dangers. The author has always warned manufacturers and users alike, that the function of an explosive is to explode, and that, although certain compositions are almost insensitive to ordinary impulses such as blows, friction, &c., yet he never believed that any explosive existed which, under favourable conditions and by proper means, could not be made to explode. It is true that Continental railways carry certain explosives, like ammonium nitrate mixtures, by ordinary goods train, and the author believes this to be an example which might be quite safely followed by British railway companies in the best interests of the public. There is no danger attached to any of these explosives when in

Fig. 11.



Ferro-concrete Building.

the safe custody of a railway van, and when they do not come in contact with dangerous goods. Even a fire will do no harm, because it is very difficult indeed to set them alight, and almost impossible to keep them alight, so that such goods could soon be moved out of the way. When, however, as was the case at Witten, large quantities of such explosives, and also trinitrotoluol and other materials, are massed together or placed close to each other, then nobody can predict the result. It has always been a good rule to keep each risk by itself.

Similarly, it will not do to plead ignorance after a number of explosions of picric acid and picrates, potassium chlorate, and the like have been properly investigated and reported upon. Disasters like those at Manchester, Griesheim, and St. Helens should not occur again.

Yet another warning to manufacturers may not be out of place. Modern explosives have introduced risks which were unknown to the former generations of powder makers, and even to dynamite manufacturers of long standing. It follows from what has been mentioned concerning the influence of high temperatures on nitrocellulose, that special attention must be paid to prevent any accumulation of dirt in places liable to exposure to heat. In the French powder factory at St. Médard, the explosion which occurred in 1891 could be clearly traced to gun-cotton dust lodging in the joints and cracks of a wooden workshop.* Do factories even now take every precaution to prevent the accumulation of dirt of this kind? The author has reason to doubt it; and a clean-up at a powder factory which he witnessed a short time ago was quite an eye-opener. He can only warn those concerned that every building where explosive dust can be produced, and every appliance and utensil therein, should be periodically and thoroughly cleaned and overhauled. More especially is this necessary in the case of drying, corning, and sifting rooms, and the trays, sieves, &c., therein, whose construction should also be such as to prevent any lodgment of explosive dust as far as possible. Imagine a drying tray, covered underneath with canvas, on which gun-cotton or powder is dried all the year round, and ask yourselves what the chemical stability of the dust may be after a year's exposure to a temperature of 40° C. (some factories dry at 50° C.), and whether a material dried on such a tray is fairly treated. I hope this warning will cause a good many buildings and appliances to be overhauled, to their great advantage.

The last twenty years have also witnessed the enormous developments made by electricity. When in 1885 the author conceived the bold plan of installing electric light in dynamite works on the lake of Lucerne, there was only a shunt wound dynamo to be had, and it was driven by a water-wheel 10 metres in diameter. The fittings had all to be specially made, as there were none in the market. This bold venture was duly punished by a thunderstorm, which flooded the mill-race to such an extent, that the water-wheel attained a speed fatal to the dynamo. The year after, the author installed compound wound dynamos at an Italian factory, but lightning struck the bare overhead wires. Happily the large number of lamps burning at the time acted as lightning arresters. In 1890, the author's Swiss dynamo was exhibited in the historical section of the Crystal Palace exhibition, and now, after Waltham Abbey led the way, an explosives factory seems inconceivable without electric light and small motors near buildings or on machines, while even the operation of drying sensitive compositions is performed by electric resistances serving as a perfectly adjustable source of heat.

Modern explosives have, on the other hand, introduced electrical dangers themselves. In the first lecture, the possibility of firing a press charge of black powder by static electricity collecting between ebonite press plates was mentioned. Nitrocellulose is electrified by the current of warm air passing over it when drying, and the necessary earthing arrangements were first proposed by Mr. Walter F. Reid, and in many cases specially designed by the author. Mixing machines for blasting gelatine and smokeless powder, especially those provided with reversing gear and belts running in opposite directions, have been known to give long sparks unless properly earthed. This was remedied at Waltham Abbey by saturating the belts with glycerine. The powder itself during manipulation will generate electricity. A workman at Ardeer wearing india rubber soled shoes on a lead covered floor was attending to a reeling machine, allowing the strands of powder to pass through his right hand. In order to joint a strand, he dipped a finger of his left hand into a bowl of acetone, when he felt a shock and a spark passed from his finger into

* "Mémorial des Poudres et Salpêtres," 1894, p. 7.

the acetone. On experimenting, it was found that this result was always obtained under these conditions, but that when a brass nail was inserted through the sole, earthing the man through the leaden floor, nothing happened.* Since that time shoes with copper rivets were introduced both at Ardeer and at Waltham Abbey. Ether vapour given off from smokeless powder and mixed with air can be fired with a very small spark, and special care should be taken in preventing its formation. The author recently investigated a serious accident of this kind. Some smokeless flake powder was being sifted in a reel covered with brass wire gauze. The charge was on the point of being finished, the bulk of the powder had been removed, and only a few kilogrammes remained in three wooden barrels under the outlets of the reel. Suddenly a crackling noise was heard, and the whole of the powder caught fire. One of the two men at work in the building survived, and there can be no doubt from his statement that the two were well away from the powder, and that this was not touched by anybody. The author could only come to the conclusion that electricity was generated in the reel, forming a spark, when the charge was finished, and that the ether vapour mixed with fine powder dust ignited.

The manufacture of high explosives seems a simple operation, even to experienced chemists, and the danger attending the process appears to be the only difficulty. As a matter of fact, it bristles with difficulties. A good many have already been mentioned, and a few additional and special points are worthy of note.

Glycerine is a uniform, easily purified substance, and its nitric ester, nitroglycerine, although sensitive to a blow, specially when frozen, is a chemically stable explosive, tame and harnessed for the service of man. Most nitro-compounds of the aromatic series have very great chemical stability. A good many of them may perhaps possess toxic properties, but can otherwise be handled with perfect immunity. There are two notable exceptions, however, amongst the explosives at present in use, picric acid and nitrocellulose.

Picric acid is a treacherous substance. It is very powerful, but that is its only recommendation. Those who use it may be asphyxiated by the fumes of a prematurely exploding shot; those who are fired at, sometime rejoice when it fails to explode. It requires special mixtures to avoid melting at high temperatures, and it attacks its metal container, forming a dangerous picrate. As an ingredient of other explosives it is useless, since on account of its acid properties it reacts upon the other ingredients. Moreover it is capable of displacing other acids, such as nitric acid in nitrates, a disagreeable property which some patentees have found out to their cost. In Montaigne's words, "I hope that we shall one day give up its use."

A more inconvenient material still is nitro-cotton. As already stated, cotton is one of the most complex substances known, and for some unexplained reason we have been in the habit of using it after an illtreatment following upon an undesirable state of cleanliness. At the best, however, we have an almost uncontrollable substance in nitro-cotton. It is in such a loose state of equilibrium that the slightest reaction will upset its balance. No wonder that when nitrocellulose is mixed with another explosive, like nitroglycerine, to form smokeless powder, it becomes less reliable and acts detrimentally on the nitroglycerine. This is accentuated still more in the presence of another disturbing factor such as heat or an alkali. I have seen cases of gelatine dynamite literally dripping with nitroglycerine, because a small quantity of ammonium carbonate added as a so-called "stabiliser" caused the decomposition of some of the nitrocellulose, and this went on to such an extent that the absorbing power of the nitro-cotton was destroyed. It is a fact that any alkali, however weak, will gradually saponify the nitrocellulose, and although dangerous decomposition would rarely set in, a bad heat test may result, and cause the nitrocellulose to be destroyed by the authorities. Chalk in water is no exception to this action.

The case is very much aggravated in the presence of heat. It is well known, that properly purified gun-cotton has been stored in all climates without giving rise to alarming decomposition, even when the temperature was above the normal. Nitroglycerine and nitrocellulose, both of which will by themselves give a potassium iodide heat test of say 20 minutes, may, however, when mixed not stand more than 10 minutes. It is a convenient excuse to say that this is due to an alteration of the physical state, but no proofs have been given for such an assertion, and I should be curious to hear of them.

The amount of nitrous acid required to colour

* Report of H.M. Inspectors of Explosives for 1901, p. 37.

the test paper is so small (according to Will* it is only 4×10^{-5} milligrams, equivalent to 0·0000016 per cent., or about 1 in 60 millions for a sample of 2·5 grammes), that whatever its physical state, there would always be enough material exposed on the surface to give off this quantity of gas in regulation time, if the explosive were of a low order of stability. There is much more justification for supposing that a chemical reaction goes on between the nitroglycerine and nitrocellulose at the elevated temperature of the heat test (82° C), the nitrocellulose being first decomposed, and the nitrous gases developed reacting on the nitroglycerine, and thus accelerating the decomposition.

We next come to the treatment a powder undergoes during manufacture. Whether passed under steam-heated or high-pressure rolls, whether kneaded for hours in a mixing machine, squeezed from a die with an unnecessary amount of pressure and friction due to a defect in or bad construction of the die, whether it be dried for weeks or months at temperatures far above the normal, everything tends to destroy the equilibrium of the nitrocellulose. Years ago the author showed that there is a critical point for mixtures, such as blasting gelatine or smokeless powders, at or about 45° C, yet during manufacture this temperature is frequently approached and sometimes exceeded.

In some countries the heat test is still carried out at a temperature of 65° C, and if the explosive stands it for say 30 minutes the result is considered satisfactory. Yet how often have we seen this temperature attained during manufacturing operations and maintained for hours! Is this reasonable?

At a certain powder factory the author found that the heat tests varied from day to day, and that the ballistic tests were quite puzzling. Investigation showed that the temperature in the drying house was badly controlled, especially at night, and intermittently rose to 50° and 60° C. A simple arrangement rendering it impossible to introduce more heat than that required to maintain the desired temperature made all the difference. Incidentally it may be mentioned that the author installed an electric alarum thermometer once only, and soon discarded it as it went off too frequently and unnecessarily.

* Dr. W. Will, "Untersuchungen über die Stabilität von Nitrocellulose. 2. Mitteilung: Der Grenzzustand der Nitrocellulose in quantitativer Beziehung." Neubabelsberg, 1902, p. 28.

We will assume now, that we have taken every precaution to manufacture an explosive, which as regards purity of its ingredients, and as regards care in its preparation, leaves nothing to be desired, and is therefore perfect in these respects. We now, as behoves careful manufacturers dreading a refusal of deliveries, wish to test amongst other things its stability, and we turn to the purchasing military authorities or the inspecting authorities for guidance. We were told everywhere until about ten years ago, and are still told so in this country, that the explosive must be heated to a temperature varying from 65° to 82° C. without developing sufficient nitrous acid fumes within, say, ten minutes to colour potassium iodide paper. The vagaries of this test are very amusing. Eleven years ago* the author was the first to show how it could be masked and falsified, and all that has been done in this country was to regulate carefully the preparation of the sample to be tested so as to remove all disturbing factors. This cannot, of course, be always assured. For instance, in smokeless powders grinding and subsequent drying will not remove all the solvent, more especially from hard dried powder. With acetone as solvent the heat test will not be a true measure of the stability, but simply a proof that the sample in question is equal to a standard sample, whose purity, together with the amount of acetone left in it, prevents a reaction from appearing on the test paper within a certain time. In other words the sample examined is not more masked than the standard sample. These two factors may, however, be quite different in the two samples. The potassium iodide paper itself is an uncertain factor. Great precautions must be taken in its preparation; while the thickness of the paper is such a disturbing factor that the papers from one official source give a test nearly double those from another. In one case tests had to be made on a large number of samples, and four different papers prepared by chemists in authority were used. It was, however, found quite impossible to obtain uniform results.

Various other tests on similar lines have been proposed to replace the potassium iodide test, but it would serve no useful purpose to describe them here. Some are free from the defects of the iodide test, but not one of them is a true test of stability. The potassium

* "The chemical stability of nitro-compound explosives." "Journal of the Society of Chemical Industry," 30th April, 1897.

iodide or the diphenylamine test, if always carried out under identical conditions, are good enough as a rough check on the manufacture, to judge whether an explosive material has been sufficiently freed from adhering impurities. They do not, however, show whether the material itself is so constituted as to remain stable. This is, perhaps, of small importance in the case of nitroglycerine or an aromatic nitro-compound with their relatively simple structure, but it is all important for nitrocellulose, where the heat test, in the opinion of most experts, is of little value as a criterion of the finished article. Hess said as long long ago as in 1879 * that an explosive may resist well, and the impurities may be present in such small quantitiesas to be insufficient to initiate decomposition of the chief constituents. In this case mere traces would be the only sign of decomposition. After their appearance, further spread of the decomposition is either not noticeable for a very long time, or it does not take place at all under the conditions of the experiment. He found this to be the case with several kinds of gun-cotton.

In order to judge of stability, the critical point at which an explosive breaks down must be found, and it is necessary to determine whether decomposition proceeds regularly or at a dangerous and increasing rate when this point is passed. A number of tests have been proposed to fulfil these conditions. They are all based on the principle that a small quantity of explosive is heated to a temperature which causes decomposition comparatively quickly, yet gives sufficient time to differentiate results. In France this temperature was 110° C., but all the modern so-called "destruction" tests are made between 130° and 135° C.

It was again Hess who, as early as 1879, tried to find the time within which decomposition took place, by passing a current of air over the heated explosive and absorbing the gases by means of a potassum iodide solution. His test was carried out at a low temperature, and lasted more than a day. He also indicated a manometric test, measuring the gas pressure developed in unit time. Will made the whole question the subject of most interesting studies, and devised a method by which the rate of decomposition could be accurately and quantitatively ascertained at short intervals of time.* Bergmann and Junck proposed another test, in which the nitrous gas liberated in a certain time was absorbed in water and its quantity afterwards determined.† Obermüller, on the other hand, measures the pressure exerted at constant volume.‡ All these tests require a considerable amount of time and constant supervision by a chemist. Having had occasion to make comparative tests with all the methods proposed, partly in conjunction with Mr. Wm. Macnab and partly with Mr. G. W. Macdonald, the author has come to the conclusion that a rapid and reliable method is to heat the explosive in long glass tubes immersed in a bath of amyl alcohol provided with a reflux condenser, and to note the time that elapses before a distinct colouration of the tube is observed. He found that this method compared very favourably with all others. Professor Will showed in 1902 § that on heating nitrocellulose at a temperature of 135° C. the quantity of gases given off is proportional to the quantity of nitrogen lost. In discussing this result,|| the author proposed a simple test whereby, with the aid of a sensitive lever balance or some other means, the loss in weight of a sample could be watched and determined. This test is now under consideration, and the results are so far very encouraging.

Now let us consider the manner in which the question of stability has been dealt with in practice. The Austrian Ordinance of July 2nd, 1877, provided in paragraph 51 that the temperature in the magazines, indicated by a thermometer constantly kept therein, must not exceed 35° C. Of course such a temperature has not been constantly maintained by anybody, unless for some reason it was desirable to dry the explosive at the same time. As the author has found, the duration of the heat test is practically halved by a rise of temperature of 5° C., and Will has confirmed this by proving that the volume of gases evolved is doubled at the same time. This is, however, only correct for temperatures above 45° C., the critical point of nitrocellulose. Below 40° C. the durability of an explosive properly

* "Mitteilungen über Gegenstände des Artillerie und Geniewesens," 1879, p. 345.

* Dr. W. Will, "Untersuchungen über die Stabilität von Nitrocellulose. Erste Mitteilung. Beurteilung der Haltbarkeit von Nitrocellulose." Neubabelsberg, 1900.

† "Zeitschrift für angewandte Chemie," 1904, p. 982.

‡ "Mitteilungen aus dem Berliner Bezirksverein des Vereins deutscher Chemiker," 1904, vol. 2.

§ W. Will. "Untersuchungen über die Stabilität der Nitrocellulose. Zweite Mittheilung. Der Grenzzustand der Nitrocellulose in quantitativer Beziehung." Neubabelsberg. 1902.

|| "Chemische Zeitschrift," 1902, p. 371.

prepared with it increases exceedingly rapidly, and it may be safely assumed that under 20° C. its stability is permanently assured.

This contention has been proved in practice. The author does not know of a single authenticated instance of decomposition in an explosive magazine where the temperature had been kept within the permissible limit.

This simple precaution was, however, neglected in a good many instances by both naval and military authorities. It was and still is the practice in men-of-war to arrange the ammunition stores and powder magazines in close proximity to boilers and engines, frequently without any ventilation, while at times explosives of all kinds are stored together. Fourteen years ago the author discussed this arrangement, and drew attention to the dangers arising therefrom.* A dozen explosions on men-of-war, and a disaster like that on the *Jena* occurred before an alarm was raised, and now all navies are hurriedly installing refrigerating apparatus. This is all very well as far as it goes, if the machinery does not break down at the critical moment; but cannot designers of warships find another place for ammunition? Why go to the length of all sorts of precautions, when it should not be impossible to remove the cause of deterioration altogether?

This misplacing of ammunition stores is only slightly mitigated by the fact that, 20 years ago, the manufacture of smokeless powders had only just begun, and that nobody knew much about them. Worse than this, however, was the action of many Governments in at once erecting their own powder works, without any experience in the manufacture of nitro-compounds to go upon, and relying entirely on what private manufacturers cared to show them, and what they themselves could find out by experiments. Some of their powders made 15 and 20 years ago are still in service, and are now the objects of suspicion.

It is nevertheless not fair to throw the whole of the blame on the explosive charge. How would the priming and detonating compositions used in gun charges and shells behave under unfavourable circumstances? Fulminate of mercury, potassium chlorate, sulphur, antimony pentasulphide, picric acid, and other chemicals are contained in such compositions, and it is open to question whether proper tests are always carried out as regards their purity and stability under all conditions. True, Hess has shown* that fulminate of mercury can be rendered quite harmless by prolonged heating; but most nitro-compounds explode, when suddenly heated, and how the products of decomposition by slow heating would react upon the other ingredients remains to be investigated.

Fearing the lack of stability in smokeless powders, which in the early days of their manufacture was not without justification, inventors began to look around for so-called "stabilizers," that is to say additional ingredients, which would neutralise the nitrous acid liberated on decomposition. Dr. Dupré's experiments had shown that the addition of an alkali was undesirable,† and the author's view‡ was often cited with approbation, that in a properly prepared explosive a neutralising agent is unnecessary, and may ultimately prove harmful. Other agents were therefore thought of, which would have no action on the nitric esters. Some people thought that if alcohol was left in the powder, it would act as a stabiliser, and in order to prevent the rapid escape of the solvent on storage, a little amyl alcohol was added, thus slightly raising the boiling point of the solvent.§ As a matter of fact, this would merely constitute absorption of the nitrous vapours, but would not prevent their being given off again on heating.

A better plan is the addition of "stabilisers," which would form stable compounds with the nitrous acid, for instance aniline, which the Nobel factory at Avigliana used in their guncotton 24 years ago, and which both they and the Italian Government employ in Service Ballistite. Diphenylamine and, it is said, vaseline, would act in a similar way. There is great difference between such real "stabilisers" and alkaline "neutralisers." In the latter case nitrites are formed, which constantly release nitrous acid on prolonged heating, and reabsorb it again, thus acting as catalysers. The stable compounds formed from stabilisers, like amidoazobenzol and other aromatic nitro-compounds, retain the nitrous acid, and thus transform the reaction into a slow and regular one, which keeps the powder in good condition as long as there is any stabiliser left. The length of time a powder remains in

* "Journal of the Society of Chemical Industry," 1904, p. 93.

* British Patents, No. 3238, of 1902, and No. 13845 of 1902.

† "Report of Her Majesty's Inspectors of Explosives, for 1887," p. 21.

‡ "The Manufacture of Explosives," London, 1904, Vol. II., p. 72.

§ "Chambre des Députés, Rapport sur les causes de la catastrophe de l' Jena," Paris, 1907.

good condition will, therefore, only depend on the proper constitution and manufacture of the powder. Possibly more strenuous advocates of the iodide heat test will again complain of a vitiation of their test; but there are, apparently, good and valid reasons for considering such additions useful, and they will have to be considered as legitimate ingredients of the powder. This has already been done in some instances.

Stabilisers, like diphenylamine and aniline will also reveal their presence, as soon as the powder goes wrong, since the compounds formed with them by the action of nitrous acid show as spots or stripes of peculiar colours, varying either in shade or intensity as decomposition progresses. Since the French Commissioners on the "Jena" accident emphasized this fact, already known in Germany and Italy, everybody speaks of *révélateurs*, the addition of an indicator, as being a panacea. As a matter of fact the author considers it only a needlessly alarming arrangement, like an alarum thermometer, and unnecessary with a good powder stored under proper conditions, but which would cause commanders of warships nervously to watch their stores after the faintest indication, without giving them any remedy in mid-ocean. This is very much like the piece of litmus paper, which, according to the Austrian ordinance of 1877, has, I believe, still to be kept in every case of dynamite, although with the present day perfection in manufacture nobody wants it. The whole idea is not new, having been patented by Nicholson and Price in 1871.*

Whilst the author believes such additions of real stabilisers to be an important improvement, he cannot consider the question of smokeless powders to be quite satisfactorily solved thereby.

What we must aim at is an explosive which is durable and stable under all ordinary conditions of use, and even under some extraordinary ones, just as in the case of the old black powder. In the author's opinion, and his view is shared by very eminent colleagues, there can be no doubt that nitro-cotton (and for the matter of that any other nitrocellulose) is not a suitable ingredient for a Service powder. Having built or reconstructed a number of works, and seen quite half of all those in Europe, he ventures to speak with some authority. Let us again recapitulate its defects. Made from a material which is most complex and liable to form unstable compounds, we elect to use it in a form which can neither be clean nor of uniform growth, nor even of constant composition. The conditions of manufacture are such that, in the absence of special precautions, the nitrocotton retains unstable compounds, and is liable to decompose. Under the influence of heat, of certain additions or ingredients, of unsuitable treatment or friction, the nitrocotton may decompose and react in a progressive manner upon the other ingredients. It requires a solvent in order to be brought into a physical state, which will permit the rate of burning of the powder to be regulated. Such solvent, if volatile, requires prolonged heating, to drive it off as completely as possible. This heating helps to shorten the life of the powder, and any solvent remaining behind affects its ballistic properties. Nitrocellulose is not a uniform compound by any means, and it is almost impossible to make sure that every batch shall have the same composition and effect. The latter by no means depend on the percentage of nitrogen being the same, though this condition may be fulfilled by suitable blending. For instance, a mixture of soluble and insoluble nitrocellulose would not have the same effect as a nitrocellulose prepared direct, although each may contain the same percentage of nitrogen.

* British Patent, No. 2430, of 15th September, 1871.

The question will naturally be asked, what will be the powder of the future? If we may venture a prophecy, the future belongs to a stable nitro-compound of the aromatic series, perhaps in conjunction with nitroglycerine. Such nitro-compounds have already been proposed, and sooner or later one will be found that meets all requirements. Although every Service will be reluctant to make a change, yet having learnt to appreciate the value of scientific research, some Government will be sure to make a bold plunge, when all others will soon follow suit.

The CHAIRMAN (Sir Boverton Redwood), in proposing a vote of thanks to the lecturer, said that he had not had the advantage of hearing the previous lectures, but he had read them, and had been very much impressed with the wealth of information which they conveyed. This did not surprise him because Mr. Guttmann was an acknowledged authority on the subject and well-known for the thoroughness with which he carried out everything he undertook. No doubt in preparing these lectures he had been largely aided by the possession of a unique library of works

in English and foreign languages in relation to this subject, and it was evident that, in tracing the early history of smokeless powders and safety explosives, it had been necessary for him to conduct by correspondence a great many enquiries in order to clear up certain points which otherwise would have remained doubtful. He (Sir Boverton) thought that all present would agree with him that probably a more instructive course of lectures had never been delivered in this Institution than that which had now come to a close. A large number of most valuable suggestions had been made, and with this had been coupled much interesting knowledge. In connection with the subject of explosives it had sometimes been said in reproach, that we honoured more highly the man who showed us how to destroy life than him who helped us to save it, but this of course was an unsound view. The best guarantee for peace was preparedness for war. An efficient explosive was a matter of necessity to all civilisation, and Mr. Guttmann had enabled us by his lectures to compare our position with that of other countries. The least they could do was to pass a very cordial vote of thanks in the usual way, for this most instructive and interesting course of lectures.*

FRENCH COLONIAL TRADE.

The foreign commerce of the French dependencies (excluding Algiers and Tunis) in 1907 amounted in value to £21,176,000 in the case of imports, and to £20,504,000 in the case of the exports. As compared with the trade of the colonies in 1906, the figures show an increase of £2,680,000 in the imports, and of £3,661,000 in the exports. Over one half of the population of the French colonies is native, and one fourth, other than French, principally Italian, but these soon become naturalised and call themselves French citizens. The colonists are becoming good customers of the mother country, and are heavy purchasers of ready-made clothing, hardware, pottery, glassware, boots and shoes, furniture, chemicals, jewellery, tobacco, cigars, wines and spirits, and other products of France. According to the French Consul at Lyons everything is done by the French Government to facilitate the exchanges between France and her colonies. The Customs duties are all at minimum rates or no more than is necessary to defray the expenses of the Customs authorities. France receives annually from her colonies large quantities of phosphates, hemp, india rubber, live stock, fresh fish, rice, cork, iron and copper ore, leather and hides, hair for brushes, wax, wheat, corn, rye, tea, cotton, several varieties of wood, and all kinds of fruit and vegetables. Early vegetables are received in France from the French colonies of Algiers and Tunis in February and March, and as soon as the supply from that source is exhausted a crop is ready in France itself. The supply of cereals from the colonies is constantly increasing, and they are susceptible of almost unlimited expansion. During the last two decades, France has expended over £8,000,000 on railways in East Africa, and the chiefs who ruled that vast territory now occupy civil and military positions, and are amenable to the authority of officials appointed by the home Government. The lines of railway worked in West Africa in January, 1908, were as follows:—Dakar to St. Louis, 124 miles; Kayes, on the Senegal, to Kulikoro, on the Niger, 345 miles; Guinea railway, Konakry to Kumy, 226 miles; Ivory Coast railway, 70 miles; Dahomey railway, Kotonu to Agovagu, 166 miles. The French are looking to the creation of a market in their colonies which will belong to them. The colonies are fast becoming an outlet for the overflow population of other nations, while they are constantly growing more thoroughly French. The official language of all of them is French. It is taught in the schools, and in Algeria and Tunis there are French universities, presided over by some of the most learned teachers of France. The names of the different places composing this immense colonial empire are as follows: — In Asia—French India, Annam, Cambodia, Cochin China, Tonkin, and Laos. In Africa — Algeria, Tunis, Sahara, Senegal, Senegambia and Niger, French Guinea, Ivory Coast, Dahomey, Congo, Somali coast and dependencies, Réunion and Comoro Islands, Mayotte and Madagascar. America—Guiana, Guadeloupe and dependencies, Martinique and St. Pierre and Miquelon. In Oceania—New Caledonia and dependencies and establishments in Oceania.

THE AUSTRO-HUNGARIAN POTTERY INDUSTRY.

The pottery industry of Austria-Hungary is largely concentrated in a single district in the western part of Austria. This is known as the Carlsbad district. The deposits of kaolin are situated at Zettlitzer and Alt-Rohlan, which adjoins Carlsbad. In that district there are thirty-five potteries, and their annual output is estimated at about £900,000. The industry owes its existence to the deposits of kaolin, or china clay, in the district of Carlsbad, along with species of quartz, which is similar to flint and to the Bohemian feldspar. A certain quantity of feldspar is imported from Sweden, and of china clay from England, for mixing. The crude kaolin as it exists in the Carlsbad district is extensive. The washing by which fine kaolin is obtained is a simple process; but though the deposits of the crude material are spread over the entire district their value is not uniform. The Special Agent of the American Government in Austria says, that to be commercially available, it is requisite that there be not more than 75 per cent. of sand, and

* As Mr. Guttmann has made arrangements for the publication of these lectures, it is not proposed to reprint them.

since many of the deposits do not yield 25 per cent. of pure kaolin after washing they cannot be utilised. Substantially, all the beds of commercially available kaolin are controlled by five companies, which have formed a combination. The combination regulates the production and distribution of the entire output, and fixes the selling price to the porcelain factories, not only in Austria but also to the factories of Bavaria and Saxony, which are dependent upon the Austrian supply. The chief seat of the manufacturing industry is at Alt Rohlan, between three and four miles from Carlsbad, and these factories are usually understood when Carlsbad is referred to, since they constitute three-fourths of all the potteries. Alt Rohlan is on the railway, and has the same facilities of transportation as Carlsbad. Most of the factories produce the finished product and market it directly, but there are several establishments doing a large export business which buy the white earthenware from the factories and decorate it themselves. The buying of this undecorated ware is a recognised branch of business, but the tendency now is for the factories to decorate and ship their own goods. Approximately 55 per cent. of the product of the Alt Rohlan potteries is exported, some of the factories confining themselves almost entirely to the export trade. In the use of the raw material some of the factories have the advantage of owning an interest in the kaolin beds and being members of the trust, but the majority have to buy the product as outsiders. The fuel supply is drawn from within a radius of one hundred miles, but most of it is much nearer, though requiring railway transportation. Some of the factories are close to the coal mines, the product of which is known as local brown, but this is of very poor quality, with inferior heating capacity, and requiring large quantities to be used in order to get results. For this reason it has little bearing on the fuel supply for the factories, its chief utility being for domestic purposes. The bulk of the bituminous coal used is brought by rail from Teplitz. Some anthracite coal is also employed. As regards the question of labour in the factories, the employment of women is reported to be increasing, though the rate of wages for similar work is less than that paid to men. The fact that domestic service in Carlsbad during the summer season, which lasts five or six months, furnishes easier employment to a large number of girls and women, has some effect on the wages in the potteries, and the manufacturers complain of the scarcity of labour during this period. The result is to keep up the average of women's wages paid in the pottery industry year in and year out. The Austrian laws forbid the employment of children under the age of fourteen. The factory laws, both in this regard and in other matters affecting the welfare of the operatives, are very rigidly enforced. The hours per week are from fifty-seven to sixty, the length of the working day being ten hours, with nine hours on Saturday in some of the factories, and with a fraction under ten hours on other days, in a few.

ARTS AND CRAFTS.

British and Foreign Embroidery.—British embroidery, and especially those branches of it which verge on "fancy-work," has of recent years been singularly little affected by what is being done abroad. This is all the more strange because there are various forces at work which would lead us naturally to expect that, at the present time, the simpler kinds of embroidery at least would be pretty much the same all the world over. The spread of commerce and of commercial methods on the one hand has meant that embroidery materials are exported largely from one country to another. Not only do we in this country export to other lands, but there is at least one enterprising Continental firm which not only sells its wares almost all over Europe, but supplies at moderate prices books of instructions (some of them very well got up) translated into various languages. These books seem to find a market everywhere, and yet they do not apparently produce quite the same results in different places. Again, the peasant crafts of various nations (and however much these may vary amongst different peoples, they always include a certain amount of embroidery) are by this time pretty well known to each other. This is due not only to the big international exhibitions, but to the small depôts opened in various places for the sale of what may be rightly, if somewhat paradoxically, termed foreign home industries. At the present time in London it is quite easy to obtain Russian, Italian, Armenian, and various other kinds of peasant needlework. Moreover, such work is, amongst certain people, by way of being decidedly fashionable. But, for all this, English work goes on its way comparatively unmindful of the various influences which we should naturally expect to find affecting it on all sides. That is perhaps partly due to the popularity in recent years of the "old English" styles, and partly to the reverence with which a certain section of the community regards the name of "Liberty,"—whilst the influence of Miss May Morris, Miss Anne Macbeth, and Miss M. E. Newill is probably felt by a good many people to whom their names are quite unfamiliar. Be that as it may, there is very little in British work which recalls very definitely what is being done abroad. The simple geometric work which originated apparently in Holland some years back, and has been copied in a good many of the countries of Europe, has found no firm foothold over here, and the Hardanger work which has had some little vogue is hardly of sufficient importance to be worth mentioning. The Russian, Swedish, Italian, and other embroidery brought over to this country, though it has been a good deal admired and a little copied by certain people, has made no real difference to what is being done by the majority of workers. It is still easy to tell at once that peasant things come from Sicily, Transylvania, Russia, or wherever it may be, and to know that we shall find nothing like them made nearer home. And even

when we turn to more accomplished work like that of Madame Hellwag at the Grafton Gallery, we find that it betrays at once by its colour, treatment, and general style that the person responsible for it is not an Englishwoman.

Swedish Embroidery in London.—Miss Clary Hahr's little exhibition at the Lyceum Club came as somewhat of a surprise. After expecting a show of English work, of which it would have been quite easy to predict that it would conform to one of two or three recognised types, there was something almost bewildering in encountering anything so completely different from what one had expected, and it was not until several minutes had elapsed that it was possible to realise that in reality the only puzzling thing was one's own unpreparedness, which had prevented the prompt comprehension of the fact that this was no English work but Swedish production pure and simple.

Miss Hahr is, of course, a competent embroideress, but her time is very largely taken up in the preparation of designs for embroidery and in beginning patterns for other people to carry out; and her designs, though they are not by any means copies, are, quite simply and frankly, on traditional lines. Indeed, it may be said that they owe no small part of their charm to a happy combination of the restfulness of traditional pattern with the energy and life of modern invention. The great part of the work shown, however, though carried out under Miss Hahr's instructions, is not worked in England, but comes over from Sweden; her studio is, in fact, not only her own workshop, but at the same time a kind of depôt for simple Swedish embroidery.

There is, of course, something to be said from the economic point of view against introducing foreign peasant work into this country. It encourages the buyer (none too ready to start with to pay a fair price for hand-work) to imagine that he can indulge in something closely akin to philanthropy and do a good stroke of business at the same time by buying foreign hand-made goods at a very small cost; and, when once he has done that, he is very unwilling, as a rule, to give even the lowest price at which it is possible to produce hand-work in this country and pay the worker anything like a fair wage. Happily, however, Swedish work does not err so badly in this respect as the lace and embroidery of many other nations, and artistically and technically we have a good deal to learn from it. There is, perhaps, nothing very great about it, but in many small points it might teach us a good deal. Swedish women are expected to be needlewomen, and they have evolved many dainty little things for themselves. Some of the Swedish drawn-work patterns, for instance, are quite different from those usually met with, and are yet extraordinarily well adapted to drawn thread, whilst the introduction of colour into the coarser kinds of drawn work is contrived very cleverly and with a far greater appreciation of what colour will do, and of the value of pure bright tints than we find, for example, in the Slav work. The *appliqué* or embroidered dress fronts (generally cloth on cloth, with a little gold thread added) are pretty and effective without entailing a great amount of work, and the patterns destined for dress trimming are schemed to get the maximum of effect out of a very reasonable quantity of work. Swedish traditional patterns on a larger scale, too, are very often peculiarly well adapted to satisfactory execution in one colour. In short, the practical needlewoman has a good deal to learn from the study of Swedish work—a study which, after a while, becomes not only fascinating but a good deal more intricate than the student would at the outset have supposed possible.

The Design Club.—It is an age of combination, and neither artists nor craftsmen, happily, are exempt from the general tendency to band themselves together in guilds, societies, and the like. The Art Workers' Guild and the Arts and Crafts Exhibition Society have been with us for a good many years; last year saw the birth of a Woman's Art Workers' Guild and a Guild of Embroideresses, and there are various other societies too numerous to mention. The latest addition to their number is the Design Club, which opens its doors in Berners-street this week. This is intended to be rather more social in character than most of the associations, and has two other marks which distinguish it from its predecessors. In the first place, it is intended primarily for designers—for those who are making or have made their living by design for manufacture, rather than for artist-craftsmen, who design their own work. In the second place, it includes as "lay members" manufacturers and others interested in art. It is this last feature which, perhaps more than anything else, differentiates the new undertaking from all previous combinations of artists and craftsmen, and which strikes at the same time an eminently practical and hopeful note. There is too much talk amongst artists at the present day about the "impossibility" of the manufacturer—manufacturers are no more than other people all of one build. There may be a certain irritable feeling among manufacturers that artists themselves are "impossible," and it is to be hoped that the new club will do something not only to promote friendliness amongst designers (who are frequently very much isolated), but also to bring about a better understanding between designers and manufacturers. If it does that, it may have a far-reaching effect not merely on design, but on manufacture. The two have been standing too severely apart of recent years.

The United Arts Club.—The United Arts Club, in its Fifth Exhibition now at the Grafton Galleries, devotes a portion of the space at its disposal to handicrafts, and has succeeded in getting together a very representative little show. The crafts most to the fore are jewellery and silversmithing and bookbinding. Mr. and Mrs. Gaskin's necklaces, pendants,

and brooches are, as usual, good both in design and workmanship, and there is a certain distinction about the work of Miss Violet and Miss Francis Ramsay. The silver and enamel mount to a feather fan by Miss Woodward is very happy in the way in which the colours of the feathers and the enamel blend, while Miss Harding has had the happy idea of designing her buckles with a view to the colour of the belts they are to clasp. There is some very good bookbinding. Mr. A. de Sauty's work somehow suggests that he has been designing for cloth lately, though the blind tooling on the back of the wooden-sided guest-book would never have been designed for anything but leather. The books shown by Messrs. Sangorski and Sutcliffe are characterised by a simplicity and a sense of proportion which are eminently satisfactory. They make one feel that a well-bound book, however slightly ornamented, is a possession to be coveted and to be proud of.

NOTES ON BOOKS.

THE ART TREASURES OF LONDON. PAINTING. Compiled by Hugh Stokes. London: Arnold Fairbairns and Co. 3s. 6d. net.

This book consists of three parts: (1) plans of the picture galleries of London with general information; (2) a chronological list of artists, arranged according to the order of their schools, including classified lists of all the pictures to be seen within the London area; and (3) a complete index to the names of the artists. Thus, a student who wishes to see all the works of a particular school will find in Section 2 the name of every picture, with the precise place in which it is hung. If he wishes to see the works of one artist, a reference to the index in Section 3 will give the page in the schools. The plan is as effective as it is simple, and should save the time of many an art-lover who wishes to find the whereabouts of any particular picture or of all the existing examples of any particular school in London. It should be added that Mr. Stokes has included in this work the University Galleries of Oxford and Cambridge.

THE TRADE AND INDUSTRY OF AUSTRALASIA. By Ben. H. Morgan. London: Eyre and Spottiswoode, Ltd. 6s. net.

In February, 1908, Mr. Morgan was instructed by the Manufacturers' Association of Great Britain to proceed to Australia and New Zealand in order to enquire into "the extent and possibilities of the market; the extent and conditions of local industries; the nature and condition of foreign competition; transport services, with special reference to shipping 'rings' and 'conferences'; and the operation of local tariffs and effects of preferences." As the author recognised, the task before him was an extremely difficult one to accomplish in a short time; but there is much to be said for his contention that "trade reports, to be of value, must be issued promptly, and contain information of current interest, in addition to recording the course of trade as closely up to the time of their publication as statistics allow." The present volume contains the result of his investigations on the state of trade, and the condition of local industries in Australia and New Zealand. Mr. Morgan, in his enquiries, was able to obtain information from the most authoritative sources—the leading statesmen in the various Colonies, the Chambers of Commerce and Manufactures and other public bodies; and being well qualified by his wide experience as Trade Commissioner to South Africa and elsewhere, he has been able to present a mass of information which should prove invaluable to all who are interested in the trade of Australasia.

GENERAL NOTES.

UNIVERSITY OF LONDON ADVANCED COURSES.—There is probably no branch of work which has done more to justify the reconstitution of the University of London than the very valuable courses of lectures on advanced subjects which the Senate have organised during the last few years. The lecturers are in many cases the highest authorities in their departments; the lectures are free to advanced students of the University and to all who are interested in the subjects treated; and the fast growing series now constitutes a record of which any University might well be proud. During the present term the following courses will be given:—1. "Roman Municipal Institutions," by J. S. Reid, Esq., M.A., LL.M., Litt.D., Professor of Ancient History in the University of Cambridge, at University College, Gower-street, W.C., on January 21st, 28th, February 4th, 11th, 18th, and 25th, 1909, at 4.30 p.m. 2. "The Spanish Drama," by James Fitzmaurice - Kelly, Esq., Litt.D., F.B.A., at King's College, Strand, W.C., on February 9th, 23rd, and March 9th, 1909, at 4.30 p.m. 3. "Physical Chemistry and its Bearing on Biology," by James C. Philip, Esq., M.A., Ph.D., D.Sc., in the Physical Chemistry Lecture Theatre, at the Imperial College of Science and Technology, South Kensington, S.W., on January 25th, February 1st, 8th, 15th, 22nd, March 1st, 8th, and 15th, 1909, at 5 p.m. 4. "The Use of Vertebrate Fossils in Stratigraphical Geology," by A. Smith Woodward, Esq., LL.D., F.R.S., Keeper of the Geological Department of the British Museum, at the Imperial College of Science and Technology, South Kensington, on February 1st, 8th, 15th, and 22nd, 1909, at 5 p.m. 5. "The Climates of the British Possessions," by W. N. Shaw, Esq., M.A., Sc.D., LL.D., F.R.S., Director of

the Meteorological Office, Reader in Meteorology, at the London School of Economics and Political Science, Clare-market, W.C., on January 22nd, 29th, February 5th, 12th, 19th, 26th, March 5th, 12th, 19th, and 26th, 1909, at 5 p.m. 6. "The Anatomy and Zoological Relationships of the Anthropoid Apes," by Arthur Keith, Esq., M.D., F.R.C.S., F.Z.S., Hunterian Professor, Royal College of Surgeons, England, in the Theatre of the Royal College of Surgeons, Lincoln's-inn-fields, W.C., on January 15th, 21st, and 29th, 1909, at 5 p.m. 7. (Under the Chadwick Benefaction.) "The Medical Aspects of Recent Advances in Hygiene as Connected with Sewering," by Louis C. Parkes, M.D., D.P.H., at the University, South Kensington, S.W., on February 2nd, 9th, and 16th, 1909, at 4 p.m.

MEMORIAL TABLETS.—During the year 1908 memorial tablets have been affixed by the London County Council to the following houses of interest in London:—(1) No. 23, Great Ormond-street, the home of John Howard, the Prison Reformer, from 1777 to 1790. He had just brought out his great work "The State of the Prisons in England and Wales," when he became the owner of this house. (1) No. 71, Berners-street, the residence of the poet Samuel Taylor Coleridge in 1812 and 1813. The original house was rebuilt and the tablet refixed last year. (2) No. 73, Harley-street, the home of Sir Charles Lyell, the Geologist, from 1854 to 1875, and of William Ewart Gladstone, the Statesman, from 1876 to 1882. During the whole period of his residence in Harley-street, Gladstone was out of office, but it was at this time that he conducted his strenuous crusade against the "Bulgarian Atrocities," which resulted in the famous "Midlothian Campaign" of 1880. (4) Holly Bush Hill, Hampstead, which was purchased by George Romney, the painter, in 1796. Here he built "an ambitious gallery for statuary and paintings, with a few living rooms attached." At this date, however, his health was broken and his hand had lost its cunning; he was lonely and unhappy at Hampstead, and in 1799 he suddenly, and without notice or explanation, deserted Holly Bush Hill and returned to Kendal and the wife he had left there many years before. (5) No. 87 Jermyn-street, where Sir Isaac Newton, the natural philosopher, lived from 1700 to 1710. During the first year or two of his residence in Jermyn-street Newton was engaged, as Warden of the Mint, in carrying out a recoinage of the currency of the realm, and he still retained the Chair of Mathematics at Cambridge and discharged the duties of his post; but after his promotion to the Mastership of the Mint he resigned his fellowship and chair at the University. (6) No. 34 Arlington-street, Camden-town, the home of Charles Dibdin, the song writer and musical composer, from 1810 till his death in 1814. (7) No. 17, Elm Tree-road, N.W., the residence of Thomas Hood, the poet, from 1841 to 1844, where he wrote what is perhaps his most famous poem, the "Song of the Shirt."

SCHOOL OF ART WOOD-CARVING.—The School of Art Wood-Carving, which has hitherto been carried on at Exhibition-road, has removed to new premises at 39, Thurloe-place, South Kensington, S.W., where classes in Drawing, the Principles of Ornament and Wood-Carving will be conducted on similar lines as heretofore.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

JANUARY 20.—"Gothic Art in Spain." By HENRY C. BREWER. MAJOR MARTIN HUME will preside.

JANUARY 27.—"The Part played by Vermin in the Spread of Disease." By JAMES CANTLIE, M.A., M.B., C.M., F.R.C.S., D.P.H.

FEBRUARY 3.—"The Problem of Unemployment." By BOLTON SMART (Superintendent of the Hollesley Bay Labour Colony, Suffolk).

FEBRUARY 10.—"Bosnia and Herzegovina." By ARCHIBALD R. COLQUHOUN, F.R.G.S., M.Inst.C.E.

FEBRUARY 17.—"The Commercial Relations of France and Great Britain." By MONSIEUR YVES GUYOT. SIR ROBERT GIFFEN, K.C.B., F.R.S., LL.D., will preside.

INDIAN SECTION.

Thursday afternoon, at 4.30 o'clock:—

FEBRUARY 25.—"The Buddhist and Hindu Architecture of India." By ARTHUR ANTHONY MACDONELL, M.A., Ph.D., F.B.A., Boden Professor of Sanskrit, University of Oxford.

MARCH 25.—

APRIL 29.—"The Problem of Indian Labour Supply." By SELWYN HOWE FREMANTLE, I.C.S.

MAY 27.—"The Function of Schools of Art in India." By CECIL L. BURNS, Principal of the Bombay School of Art.

COLONIAL SECTION.

Tuesday afternoon, at 4.30 o'clock:—

FEBRUARY 2.—"The Production of Wheat in the British Empire." By ALBERT E. HUMPHRIES, Chairman of the Home-Grown Wheat Committee. The Rt. Hon. EARL CARRINGTON, K.G., G.C.M.G., will preside.

MARCH 16.—"The Colonial Wool Trade." By S. BANKS HOLLINGS.

APRIL 6.—"Ceylon: its Industries and Material Progress." By the Hon. JOHN FERGUSON, C.M.G.

MAY 4.—

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

G. L. ADDENBROOKE, M.I.E.E., "The Public Supply of Electric Power in the United Kingdom." Three Lectures.

LECTURE I.—JANUARY 18.—Statistics of the power employed in the United Kingdom—The opening for electrification—Public supply of power by local authorities and companies—The present position—Prices of power supply—Power used in proportion to labour—The influence of load and diversity factors — Capital cost of power supply undertakings.

LECTURE II.—JANUARY 25.—The working costs of power supply undertakings of different sizes and the prices at which they can supply energy—The modern power station.

LECTURE III.—FEBRUARY 1.—The distribution of electric energy at high pressure—Electric energy at the consumers—The development of electric power supply in the United Kingdom—Some observations on the legal position and on the relations of public and private enterprise.

LEON GASTER, A.M.I.E.E., "Methods of Artificial Illumination." Four Lectures.

February 15, 22, March 1, 8.

GEORGE GERALD STONEY, M.Inst.C.E., "Steam Turbines." Three Lectures.

March 22, 29, April 5.

F. W. LANCHESTER, "Aerial Flight." Three Lectures.

April 26, May 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 18...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. G. L. Addenbrooke, "The Public Supply of Electric Power in the United Kingdom." (Lecture I.)

British Architects, 9, Conduit-street, W., 8 p.m. Mr. R. S. Ayling, "Public Abattoirs."

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Dr. Alfred T. Schofield, "Science and the Unseen."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. A. J. Windus, "County Council Finance and Audit."

TUESDAY, JAN. 19...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Karl Pearson, "Albinism in Man." (Lecture I.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on papers by (1) Mr. John Wyatt Spiller, "High Speed on Railway-Curves," (2) Mr. William Hamilton Shortt, "A Practical Method for the Improvement of existing Railway-Curves."

Photographic, 66, Russell-square, W.C., 8 p.m. Mr. R. F. Jameson, "Holy Days and Fête Days in Spain."

University of London, King's College, Strand, W.C., 5 p.m. (Creighton Memorial Lecture.) Dr. G. W. Prothero, "The Arrival of Napoleon III."

Royal Statistical, 9, Adelphi-terrace, Strand, W.C., 5 p.m. Mr. Percy E. Braun, "The Cost, Conditions and Results of Hospital Relief in London."

WEDNESDAY, JAN. 23...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Ordinary Meeting.) Mr. Henry C. Brewer, "Gothic Art in Spain."

Meteorological, 25, Great George-street, S.W., 7½ p.m. Dr. Hugh Robert Mill, "Some Aims and Efforts of the Society."

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Presidential Address by Lord Avebury, "Seeds, with special reference to British Plants." 2. Exhibition of Foraminifera dredged from off the coast of Somaliland.

United Service Institution, Whitehall, S.W., 3 p.m. Mr. E. T. Scammell, "The Commutation o Naval and Military Pensions, with special references to the Openings for suitable Pensioners in our Over-Sea Dominions."

Mining and Metallurgy, Geological Society's Rooms, Burlington-house, W., 8 p.m.

THURSDAY, JAN. 21...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. Arthur W. Hill, "The genus *Nototriche*, Turcz." 2. Dr. Percy Groom, "The Longitudinal Symmetry of Centrospermeæ."

Chemical, Burlington-house, 8½ p.m. 1. Messrs. F. S. Kipping and H. Davies, "Organic Derivatives of Silicon." Part IX. "Experiments on the Resolution of Di-benzylethylpropylisobutylsilicane Sulphonic Acid." 2. Mr. F. D. Chattaway, "Synthesis of Diurea from Urea." 3. Messrs. F. D. Chattaway and D. F. S. Wünsch, "Chlorine Derivatives of Substituted Ureas." 4. Messrs. F. Tutin and H. W. B. Clewer, "Chemical Examination of Eriodictyon." Part II. 8. Mr. S. U. Pickering, "The Hydration of Precipitates." 6. Mr. J. E. Purvis, "The Relationship between the Constitution and the Absorption Spectra of Pyridine and various Derivatives." 7. Mr. S. Ruhemann, (*a*) "The Formation of Cyclohexanone Derivatives;" (*b*) "The Action of Mustard Oils on the Ethyl Esters of Malonic and Cyanoacetic Acids" (Part II). And other papers.

Optical Society, 20, Hanover-square, London, W., 8 p.m. Mr. W. J. Wright, "Advantages and Disadvantages of Objective and Subjective Methods of Sight Testing."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. Arnold White, "The Outlook for Britain."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. J. O. Arnold, "Mysteries of Metals." (Lecture I.)

Historical, Field-court, Gray's-inn, W.C., 5 p.m. Mr. C. L. Kingsford, "Sir Otto de Grandison (1238 1328), the Friend and Secretary of Edward I."

FRIDAY, JAN. 22...Royal Institution, Albemarle-street, W., 9 p.m. Dr. A. R. Wallace, "The World of Life as Visualised and Interpreted by Darwinism."

Architectural Association, 18, Tufton-street, S.W., 7½ p.m. Mr. H. T. Buckland, "Schools."

Physical Society, Physics Laboratory of the Royal College of Science, Imperial Institute-road, South Kensington, S.W., 5 p.m. 1. Dr. A. Russell, "The Effective Resistance and Inductance of a Concentric Main, and Methods of Computing the Ber and Bei and Allied Functions." 2. Dr. C. V. Drysdale, (*a*) "The Luminous Efficiency of a Black Body;" (*b*) "The Use of the Potentiometer on Alternate Current Circuits."

SATURDAY, JAN. 23...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Sir Hubert von Herkomer, "The Critical Faculty. (Lecture I.)

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FRIDAY, JANUARY 22, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, JANUARY 25th, 8 p.m. (Cantor Lecture.) G. L. ADDENBROOKE, M.I.E.E., "The Public Supply of Electric Power in the United Kingdom." (Lecture II.)

WEDNESDAY, JANUARY 27th, 8 p.m. (Ordinary Meeting.) JAMES CANTLIE, M.A., M.B., C.M., F.R.G.S., D.P.H., "The Part Played by Vermin in the Spread of Disease."

Further particulars of the Society's meetings will be found at the end of this number.

PROCEEDINGS OF THE SOCIETY.

SWINEY PRIZE.

A meeting of the adjudicators of this prize, appointed under the will of the late Dr. Swiney, was held at 4.30 p.m., on Wednesday, January 20, 1909, at the Royal Society of Arts. SIR WILLIAM H. WHITE, K.C.B., F.R.S., Chairman of the Council, was in the chair.

The Secretary read the advertisement convening the meeting.

The Secretary read a report from the joint Committee of the Royal Society of Arts and the Royal College of Physicians, recommending that the prize should be awarded to Dr. Charles Mercier, for his book, "Criminal Responsibility."

It was thereupon moved by Sir Richard Douglas Powell, K.C.V.O., late President of the Royal College of Physicians, seconded by the Lord Chief Justice, and resolved, "That the prize be adjudged to Mr. Charles Arthur Mercier, M.D., F.R.C.P., F.R.C.S., author of a published work on "Criminal Responsibility."

SIXTH ORDINARY MEETING.

Wednesday, January 20, 1909; MAJOR MARTIN HUME in the chair.

The following candidates were proposed for election as members of the Society:—

Andrew, John Ingram, M.Inst.N.A., Messrs. G. Fenwick and Co., Limited, Hong Kong, China.

Arundel, Sir Arundel Tagg, K.C.S.I., Uplands, Maybury-hill, Woking.

Benson-Nicol, Louis Hotspur, Warri, Southern Nigeria.

Bowden, Cyril, F.R.C.I., F.R.G.S., Union Club, Malta.

Brown, William Hervey, Standard-buildings, Leeds.

Cheah Cheang Lim, Ipoh, Kinta, Perak, Federated Malay States.

Deacon, Octavius, 150 and 154, Leadenhall-street, E.C.

Fortescue, Nathaniel, J.P., Hainhault, The Drive, Chingford, Essex.

Golding, Henry J., 16, Algiers-road, Ladywell, S.E.

Gupta, Karunakanta Das, B.A. (Cal.), Sibsagar, Assam, India.

Harvey, George B., 4, St. James's-street, S.W.

Headlam, Lieut. Edward James, R.I.M., care of Director of Royal Indian Marine, R.I.M. Dockyard, Bombay, India.

Henriques, Alexander Lindo, Bocas del Toro, Republic of Panama.

Jaggard, William, 139, Canning-street, Liverpool.

Khoo Cheow Teong, 24, Light-street, Penang, Straits Settlements.

Khoo Siew Jin, Kuching, Sarawak, Borneo.

La Touche, Sir James Digges, K.C.S.I., 14, Gledhow-gardens, S.W.

MacGregor, John Stewart, Briar Bank, Francis-street, Leeds.

Martin, Robert M., 34, Molesworth-street, Dublin.

Maruta, Hidemi, Mitsu Bishi Dockyard and Engine Works, Nagasaki, Japan.

Mhatre, Mungalrao Ramjee, 268, Kumbharwada-street, Girgaum, Bombay, India.

Mistry, Shapoorjee Dhunjeebhoy, Chief Engineer, The Gujarat Ginning and Manufacturing Company, Kolupur Post, Ahmedabad, India.

Peters, Major Cecil, Sunbury Manor, Middlesex.
Phillips, John, 36, Lincoln's-inn-fields, W.C., and 20, West 25th Street, New York City, U.S.A.
Reid, Edward George, Colonial Surveyor's Office, Turks Islands, British West Indies.
Roxburgh, William, 25, Portland-road, Kilmarnock, N.B.
Scott, John C. H., 13, Watling-street, E C.
Sethna, Nowroji Sorabjee, 76, Gogha-street, Fort, Bombay, India.
Stewart, Charles William Arnott, 2, Marchmont-road, Richmond, Surrey.
Stones, William, Northwood, Seymour-grove, Old Trafford, Manchester.
Wee Hap Lang, 19, Roger-street, Kuala Lumpur, Selangor, Federated Malay States.

The following candidates were balloted for and duly elected members of the Society:—

Broadbent, Cecil, 63, St. James's-street, S.W.
Burton, Henry, Messrs. Partington and Co., Victoria-embankment, W.C.
Everest, Miss Ethel Gertrude, Chippens Bank, Hever, Kent.
Macgowan, Rev. John, Amoy, China.
Probert, Rev. William Mitchell, 71, Gore-road, Victoria-park, N.E.
Singer, Adam Mortimer, 78, Mount-street, Grosvenor-square, W.

The CHAIRMAN, in introducing the reader of the paper, said that, while other artists, eminent in their way and graphic in their work, had been able to impress upon the people in this country the beauty of certain details of Spanish buildings and cities, he knew of no artist in England who had been able to seize their general effect and impression as Mr. Brewer had done.

The paper read was—

GOTHIC ART IN SPAIN.

By HENRY C. BREWER.

In few countries has the influence of history on art been so marked as in Spain during the Middle Ages. The Moorish invasion of the greater part of the Peninsula early in the eighth century drove the Gothic races into the romantic fastnesses of the North, and there for three centuries, weakened by internal warfare, the Moors remained.

In the eleventh century the Christians, having regained their energy, reconquered Toledo and united the two Castilles. Henceforward and by degrees the Moors were driven southward, and finally, in the fifteenth century, the whole Peninsula was again under Christian rule. During these times the two great streams of Gothic and Saracenic art ran side by side, scarcely influencing each other, but steadily marking the advance or retrogression of each nation.

The mediæval Spaniards, born among such surroundings, and fired with that enthusiasm, the torch of which was kept burning by defending their faith and homes against a Mohammedan race, developed those national feelings for romance and drama, which influenced their lives and work, so that romance and drama constitute the characteristics of their Gothic art.

The first serious attempts of Gothic art in Spain date from the end of the eleventh and beginning of the twelfth centuries, and the work is suggestive of the influence of the rich Romanesque art of the South of France, which art is a little earlier in date. It is also significant that the episcopate of the newly reconquered city of Toledo was held by a Frenchman, Bernard by name, through whose influence many French clergy were preferred to important positions in the Church in Spain.

The cathedral of Santiago in Galacia, that of Zamora, and the old cathedral of Salamanca, are the three leading churches of the first period of Gothic art in Spain. Santiago, commenced about the year 1078, is the earliest and largest. It is a noble example of a Romanesque church, cruciform in plan, with an apse surrounded by chapels and richly-carved Western doorways. The fact of its completeness and general unity of style would make it most remarkable, for there is nothing in Spain of an earlier date which could lead up to such completion; but its great similarity to St. Sernin at Toulouse, which is earlier in date, makes it more than probable that the work was entirely carried out under French guidance, and although a more noble work than the other two, it is perhaps less interesting to the student of Spanish art. Zamora and Salamanca are smaller and later in date, but they have that individuality of their own which suggests that they were the cradle of Gothic art in Spain. These interesting structures were commenced early in the twelfth century; they are cruciform in plan, the crossing being covered by a dome or cupola surrounded by small windows. Internally the massive stone piers support simple unmoulded arches and the window

spaces are but small apertures in the walls. A simplicity and unity of effect is obtained by the mass of light which pours in through the windows surrounding the cupolas and centres on the piers which support the crossing. This massing of light was the first suggestion of the drama of effect which stands out so conspicuously in the Gothic art of Spain.

The little old cathedral at Salamanca is now enveloped in the folds of the vast Gothic edifice which has superseded it, and it is difficult to gauge its earlier appearance. Zamora, on the other hand, is as it was 800 years ago. Rising on a rock on the northern bank of the river Douro, the time-honoured fortress and "well-walled town" retains much of its ancient warlike appearance. It is, however, no longer surrounded by all of its seven lines of walls; still it has that appearance of impregnability for which it was noted in mediæval times. Seen above the old brown walls, on the highest part of the rock, is the cathedral, strangely picturesque in outline. At the west end is a Romanesque tower of unusual proportions, and a dome at the crossing, transitional in style, but Eastern in appearance; these crown a short, massive church, which is more like some castle keep than a Gothic cathedral. This building, and that of Salamanca, were in progress during the episcopate of that warlike prelate, Geronimo, the confessor to the Cid, and well express the race and times.

The city of Avila, near Madrid, is even a more complete mediæval city than Zamora. It is surrounded by walls commenced in the year 1090, and is now the most perfect example of a walled city in existence. Mapped out on the slope of a hill, and looking much like an engraving in the Nuremberg Chronicle, it has stood still since the walls were the protection of its inhabitants, and is unaltered except by decay. Within these walls are three interesting examples of early Gothic art—the Cathedral, St. Vincente, and St. Pedro. The date of their architecture is a little later than Salamanca and Zamora, yet in part they are coeval. The cathedral is a lofty cruciform church of the twelfth and early thirteenth centuries. The beautiful granite nave, flooded with light from the lofty clerestory windows and noble choir built in a red veined stone, suggest but faintly the massiveness without. The transitional apse, forming a vast bastion in the walls and externally throughout the church, presents a fortress in itself, well suggesting the militant Christianity of mediæval Spain. St. Vincente and St. Pedro are both twelfth century buildings, the west front of the former being the glory of Avila. Set back beneath an arch which joins the two short Western towers, is a late Romanesque double doorway, the archivolt of which is richly carved and moulded, the classical acanthus leaf being amongst the details. Saints supported on columns stand against the jambs and dividing pier, and these, although a little crude in treatment, have a great amount of human feeling, and are earnestly engaged in conversation with each other.

The Spanish peasants think that the saints which grace the niches of their churches, come down from their positions once in every hundred years, and, if they overstay their time, they turn again to stone, and so cannot return, and this is why there are so many empty niches.

Internally the church is solid and massive, with arches supported on circular columns, and vaulted with boldly-moulded cross ribs. St. Pedro, although less imposing, is as interesting as St. Vincente. The beautiful crossing is Romanesque, and is lit by a fourteenth century lantern, which it supports. The roughly-chiselled carving and masonry, here brought into prominence by the light, melt away into the mysterious gloom of the nave transepts and chancel.

Tudela and Tarragona are exceptionally fine examples of transitional architecture. Tarragona by some is thought to be the finest building in the Peninsula. The general date of this great work is the latter part of the twelfth and early thirteenth centuries. The apse, however, which is Romanesque, is early twelfth century work. Internally, the simple, solid dignity of the unmoulded arches, supported on massive stone piers, is relieved by grotesques and scrolls carved on the caps and in the string-courses; the grand balance of light and shade, and the beauty of proportion, are expressive of the manly power of this early style of architecture, a style in which Spain is especially rich. The interesting lantern at the crossing, formed into an octagon by pendentives in the spandrils of the arches and vaulted with bold groining ribs, is, I think, the first example of such a treatment in architecture. The cloister court is one of those silent gardens of loveliness in which architecture, mellowed down by time, combines with nature to form a dream of colour. The early pointed arches of the cloister, divided by round-headed windows and circles enriched with the dog-

tooth moulding, peep out between the luxuriant foliage which rises from a garden divided into paths by clipped and flowering shrubs, while here and there a fountain cools the fragrant air with its sparkling jet of water.

The cathedrals of Toledo, Burgos and Leon, were built in that great period of mediæval art, the thirteenth century. Toledo, grandest of the three, is the finest example of Gothic in the Peninsula, and its solid magnificence, vast scale, and the richness of its fittings place it amongst the finest buildings in the world.

The King Don Ferdinand III. and Archbishop Rodrigo laid the first stones of this church on the 14th of August, 1227, and the architect, according to a contemporary inscription, was Petrus Petri. It is unfortunate that this inscription is in Latin, for it makes it impossible to decide with any certainty whether he was a Spaniard. Those who claim everything in Spain to be done by others than Spaniards, state that he was a Frenchman, Pierre le Pierre, while the Spaniards claim him under the name of Pedro Perez. Whether, however, Petrus Petri was a Spaniard or Frenchman, there is no doubt that on entering this grand building one is struck with an effect essentially different from that created by churches in other countries. The sombre impressiveness, the proportions, the drama of chiaroscuro stamp it with a distinct individuality, and even should the root have been transplanted from the soil of France, the tree has assimilated the poetry and drama of its Castillian surroundings. Its proportions are colossal, it being the third largest church built in Gothic times. Seen from the transepts it conveys the finest impression; the brilliant Spanish sunlight pierces the richly-coloured windows, striking in diagonal shafts across the dark, mysterious voids, here and there lighting up a column or exquisite bit of carving, and glistening on the silver chastening and copper-gilt details of the screen. The air is filled with the aromatic scent of incense, and the pale, grey smoke which rises from the censers lingers about the cavernous arches, and mingles with the mysterious atmosphere which envelopes the vaulting. Nowhere else is architecture so dramatic, so full of mystery. The cathedral is cruciform in plan, with an apse at the east end, and has double aisles which are continued round the chevet. The capilla major is enriched with carvings and tombs of the fourteenth, fifteenth and sixteenth centuries, and cut off from the transepts by the most interesting and magnificent metal screen in the country of metal screens—Spain.

The high altar is in late Gothic design, elaborately carved in wood, gilded and painted, and, altogether, this capilla major is the most gorgeous work of Gothic art in existence, and well represents the epithet of wealth applied to Toledo Cathedral (Toledo for wealth, as the Spaniards say). The stalls are in delicate Renaissance work, and were designed by Maestro Rodrigo in the year 1495, and the metal screens by Domingo Cespedes in the year 1548.

This jewel of Gothic art is set in the crown of Spain. Toledo—the once imperial and magnificent, now forlorn and desolate—is but the skeleton of the past. Built on a rock of granite, the venerable frame stands like a rock, on a rock girdled round by the river Tagus boiling through a ravine at its feet. In this city is epitomised the whole history of the Peninsula: Romans, Visigoths, Saracens, and again Christians, have in turn held sway, and here all have left their mark. Crossing the wild and melancholy river and linking up its rock-bound sides are two bridges, part Gothic and part Saracenic—the bridge of the Alcantara and the bridge of St. Martin. When arriving at Toledo, one enters the city by crossing the bridge of the Alcantara. Passing under the portcullis of the gate, one indeed feels that one has left the dull commercial world of the present day, and is entering the age of chivalry. On the further side of the bridge still stands the Moorish tower restored in Gothic times, and the narrow road supported on one great arch which spans the river was rebuilt in the thirteenth century. A small panel in the wall records the fact that it was rebuilt after a great deluge of rain commencing before the month of August and lasting until the 26th of December in the year 1258. The bridge of St. Martin is even more interesting than that of the Alcantara. The great spanning arches were rebuilt probably after the same flood. The gateway, however, is a work of Moorish art of the ninth century. Above the bridge rises a grand view of the rock-built city. Conspicuous is the church of St. Juan Los Reis, the walls of which are covered with votive manacles given by descendants of families who were freed from Moorish bondage when Toledo was reconquered.

The great works in Toledo are numberless, but we cannot leave this city without mentioning the one small vein of art into which the streams of Christian and Saracenic architec-

ture intermingled, and gave the very rare style of moresque. In a town which had been reconquered by Christians after the Moorish occupation, many Moors of the artisan classes remained, and being a skilful people they were employed on the buildings erected by their Christian masters. On rare occasions these buildings were entrusted to their hands, and in these one finds a style founded on Gothic construction, but in detail Moorish; such is the thirteenth century brick tower of St. Ronan, the apse of St. Christo de Luz, and several other churches. In the choir triforiums in the cathedral there is a slight suggested trace of Moorish influence in the upper arrangement of the interspanning arches, but here it is the motif which is Moorish, the detail being purely Gothic.

The foundation-stone of Burgos Cathedral was laid in the year 1221, during the episcopate of Bishop Maurice, an Englishman, and the original fabric of this great church was completed in the incredibly short time of nine years. The church is cruciform in plan with single aisles and an apse, and is surrounded by lateral chapels. Externally the rich outline of the spires, octagon, and great octagonal chapel at the east end, are features superimposed on the original structure, and, owing to the situation, these additions are always conspicuous, and give the appearance of a church of much later date. The interior is a magnificent example of architecture. At the moment of entering from the western doorways the effect is somewhat injured by the blocking up by the coro, but from the choir or transepts, the fine effect of proportion, the drama of chiaroscuro, the beauty of the carving and the richness of the fittings are unsurpassed. No doubt much of this effect is given by the light flooding in from the late octagon, which octagon is condemned by authorities who can see beauty only in purity of style and academic art; still, those of broader mind can at least here put on one side their more fastidious tastes to enjoy what is probably the most perfect drama in architectural art.

The old Gothic lantern having fallen down in the year 1539, the present one was commenced by Juan de Borgona, and completed by Juan de Vallego in 1567. It is Gothic in form, but plateresque in detail. From an architectural point of view it does not bear analysis, but as a combination of motif and detail it triumphs over rule, and produces one of those impressions which time can never obliterate.

The spires and octagonal chapel were designed by John of Cologne, and carried out between the years 1435 and 1456; and, although German in style, the detail is much influenced by Spanish art. The interior of the octagonal chapel is vaulted in most delicate interlacing work of late Gothic design. The stone is smooth and cream coloured, and the carving throughout is so exquisitely minute that the general suggestion is that of an ivory casket. In front of the Renascence altar is the tomb of Don Ferninando de Velasco, the Constable of Castille, for whom this chapel was built, and it is still the property of the same family.

The cathedral at Leon, commenced in the year 1214, is much more correct according to the laws of Northern Gothic architecture. Lightness and grace are its chief features; the aim seems to have been to use the least possible amount of material with the greatest amount of space and effect. In France, at the same period, a similar attempt was being made in the church at Beauvais, and in both a like result followed — that of the constant difficulty of keeping the church in structural stability. It is quite northern in plan, and although not nearly so long, otherwise the proportions are the same as those of Westminster Abbey. The bays are lofty and slender, the triforium pierced, and the clerestory, which is nearly half the height of the building, completely filled in with a six-light window. Shortly after its erection, however, for the sake of increasing its stability, two of the lights were filled in. Externally the church is not satisfying when compared with such exquisite examples of this style of architecture as those existing in the north of France. One cannot but help feeling that here the Spaniard was treading on ground which he did not fully understand, and that there is little really Spanish in this undoubtedly fine cathedral.

Elsewhere in Spain one comes across this extremely lightly-built Gothic, but the style never left its French origin, and was never quite satisfactory on Spanish soil. Perhaps the best works in this style of art in Spain are the western doorways of the cathedral at Vitoria. These are perfect examples of northern French art, and suggest not only that the architecture was French, but that even the carvers and masons must also have been. This cathedral and one or two of the churches in Vitoria are so lightly constructed in stone that great uprights have been placed in front of the columns to give extra stability

to the vaulting, a necessity which is quite ruinous to their achitectural effect.

In the fourteenth century Gothic art in Spain developed more purely on national lines, and French influence seems to have quite disappeared. The most interesting buildings of this period are to be found in Catalonia and Aragon. A school of architects had sprung up in the Island of Majorca of which the leading light was Don Jaime Fabre. Much interest had been aroused by the Dominican church he was erecting at Palma at the end of the thirteenth century, now unfortunately destroyed except the cloisters, which are used as a prison.

In the year 1298 the King summoned Fabre to Barcelona and requested him to make plans for the new cathedral. These designs were put in hand at the commencement of the fourteenth century, and a very interesting agreement between Fabre and the clergy is still in existence. According to this agreement Fabre was both architect and builder. It enters minutely into all arrangements about payments and duties of the architect, and I think I am right in saying that it even states that during Fabre's residence in Barcelona he was to have two new hats a year. This cathedral is oblong in plan, with an apse at the east end, the crossing formed by the transepts being flush with the outer walls of the aisle chapels. At the west end is an octagon only partly carried up in mediæval times, but now being completed. The nave is very lofty, and the groining of the roof starts from the caps of the nave piers, leaving but small space above. The triforium and clerestory are represented by a narrow arcade and circular windows. The window spaces are all small except those round the apse, and they are filled with fine old glass. The chevet is seven-sided, the tall slender columns supporting stilted arches, and the stone is a rich russet colour. When one enters the transept door from the brilliant sunlit streets the darkness is profound; but by degrees, as the sight gets accustomed to the gloom, here and there parts of the glorious architecture stand out where they intercept shafts of light, and the tall graceful arches of the chevet rise in dark relief against the jewelled background of the richly-coloured glass in the apse. Boldly bracketed out above an arch in the north transept, the great organ rears its mass of finely-carved plum-coloured wood, and the delicately canopied stalls in the trascoro form a filmy group of cobweb spires, from the sides of which spring up the piers of clustered shafts supporting the arches and groining of the roof. All above, though, is lost in mystery — a dark impenetrable mystery, through which floats the pale blue smoke of incense.

The great French cathedrals may be finer architecturally, may be more perfect in proportion and detail than this church, but is not the atmosphere which pervades a building more eloquent than the stone itself, and can architecture rise beyond that which impresses the mind with the mystery which surrounds our life and leads us to the contemplation of a future state?

The cathedral of Palma, rising in a golden mass of masonry from the shores of the Mediterranean; the square-planned cathedral of La Seo, at Saragoza, and many others in this district, are all remarkable for that strange impressive atmosphere, and, like great works in Nature, grasp the mind and lead the thoughts to contemplate the mysteries of the future.

The cathedral at Gerona is another exceptionally interesting fourteenth and early fifteenth century building. The choir apse and choir aisles are planned on the usual French arrangement, and were carried out in the early fourteenth century. In the year 1416 Guillermo Boffy, who was then master of the works, made a design for completing the church by the addition of a nave of a single vault of 75ft., the arch completely spanning the choir and its two aisles. As might be imagined, this suggestion seemed so hazardous that the chapter of the cathedral called together a meeting of the most illustrious architects of Spain to discuss the possibilities of such an erection. After due deliberation the designs were approved, and this, the widest Gothic vault in the world, was erected; it is at the present day in perfect structural condition. (For comparison with our English churches, Westminster Abbey is 38 ft., and York, our widest span, 52 ft., whereas Gerona is 75ft.) When one enters, the great cavernous space appears larger in proportion than it really is. That mysterious gloom which is usually present in Spanish churches is here pierced by a great diagonal ray which, striking from the south windows, floods the three chancel arches with light. Far off in the distant gloom, are seen the graceful, stilted arches of the chevet, and here and there a jewel of colour sparkles in the windows of the apse. The artistic effect is perfect, the drama sublime. This arrange-

ment of light and shade is undoubtedly as much part of the design as the columns and arches, the groining of the roof or plan. This mass of light passes through three richly-stained glass windows in the south-east corner of the nave; all other window spaces are but panels in the walls. Critics say this grand effect is but the outcome of chance, that the architecture, being borrowed from a Northern source, had too much window space, hence much had to be blocked up, and time, the mellower of all things, has mellowed down a crude and barbarous makeshift. Has time or accident written avarice in the eye of the moneylenders by Quentin Mitsys, or woven the golden light which illuminates a head by Rembrandt? No, this is art, consummate art—art which is akin to that of poetry and music.

Many of the documents connected with these great buildings are remarkable, for they prove how great was the care and thought bestowed on every minor detail. Perhaps one of the most interesting is that connected with the completion of the Miguelete at Valencia. This proves that even in the days when Gothic was a living art it could not be produced without great effort, and, just as to-day, resort had to be made to selection. This manuscript states that Peter Balaguer, an able architect, shall receive 50 florins from the fabric fund of the new campanile in payment of his expenses on the journey which he made to Narbonne, Lerida, and other cities, in order to see and examine their towers and campanili, so as to imitate from them the most elegant form for the completion of the tower at Valencia. This tower was commenced in the year 1381, Juan Frank being the architect, and evidently, the tower not being considered satisfactory, they sent this other architect to get some better suggestions for its completion than that of the original designer.

The romantic beauty of this rock-bound land gave opportunities quickly grasped by mediæval builders, and Manresa, in its poetic situation, is one of those dreams in which they loved to dwell. Perched on the summit of a rock which is broken into picturesque hollows filled with gardens, the church crowns the lofty eminence; crossed by ancient bridges at its base, the rushing river Leobregat winds between huge rocks and olive yards; and faintly seen on the horizon are the pale blue mountains, far off spurs of the noble range of the Pyrenees. The great ship-shaped rock, Segovia, is at times an unequalled vision of romance. Built up amongst the mountain heights, the mists descend, and as they slowly wind around its base, it seems as though the rock-built ship is moving, supporting on its decks the wall-girt town, the prow crowned with the towers and turrets of its castle. The situation is, indeed, unsurpassed for beauty and strength. In the castle, which in mediæval times was impregnable, was kept the money reserve of the kingdom, the mint being in a small building on the river at the base of the rock.

The fifteenth century gave to Spain its largest and, perhaps, most famous Gothic work and the largest Gothic church in the world—Seville Cathedral. It was commenced in the year 1403, and completed about a century later. The great building covers an oblong, 414 feet long by 271 feet wide. It has double aisles and lateral chapels. The coro, as is usual in Spain, fills up the centre of the nave. This arrangement of the coro is necessitated by the elaborate ceremonies and the number of clergy who take part in them. The centre of the church being enclosed led to the buildings being planned shorter and broader so as to allow more space for the people crowding round the sides of the high altar to attend the sermons at High Mass. In the larger cathedrals, such as Toledo, Burgos, Seville, &c., there are sometimes two or three high masses, with organ and full choir proceeding at the same time. The public, as a rule, attend masses in the side chapels, and the service at the high altar—except the sermon—appears to be principally for the clergy.

This arrangement, by which the choir is continued into the eastern bays of the nave and enclosed by stone screens (the trascoro) has been very adversely criticised by authorities on architecture, and from the point of view of the general vista, on entering by the western doorways it certainly is in many cases most injurious. The screens themselves, however, and the fittings which they enclose are occasionally of such great beauty that they sometimes even more than compensate for the injury done. This arrangement was probably introduced in the fourteenth century, the period at which the churches became much squarer in plan. In such a church as La Seo, at Zaragoza, which has a nave and four aisles all of the same height, and with the length and breadth equal, the enclosed coro adds immensely to the effect.

The interior of Seville is noble in the ex-

treme. The massive nave piers rise in moulded shafts, broken only by narrow caps running round the arches and groining of the roof. The immense height of the arcade is carried through the space, which in most cases in our English churches would be the triforium. This gives the proportion which so great a scale requires. Beyond the crossing the high altar towers above the coro in a dark mass of carved and gilded wood, and between the nave piers is seen the forest of massive columns which support the double aisles and surrounding chapels.

The sombre majesty of the effect, the richness of the glass and fittings, the dignity of the architecture, well portray the Spanish epithet of solemnity applied to this cathedral, and produce an effect akin to that experienced when contemplating the greater works of Nature. In 1889, part of the vaulting above the choir fell down, and fear was felt for the general stability of the building. This damage has been repaired, and so excellent is the restoration that the appearance of the building is quite uninjured.

In the sixteenth century, when most countries had adopted the Renaissance art, Spain still held on to Gothic form for its ecclesiastical architecture, and the two great buildings of Salamanca and Segovia are the last great Gothic works erected. In the year 1513 the clergy called together a number of architects to draw up a report setting forth the essentials of such a building as they wished to have. This report decides not only the size and proportion of the building, but even such projections as buttresses, &c. Amongst these architects Juan Gil de Hontanon was selected by the chapter to carry out the building. In 1522, the same architect was called in to design the cathedral at Segovia; at his death this work was completed by his son, Ridrigo Gil de Hontanon, in the end of the sixteenth century. These two great buildings, the last spark of the fire of Gothic art, group up in massive towers and domes, crowning the towns over which they rise with majesty and domination. In detail, perhaps, they do not bear analysis—they may have faults of ostentation—but as expressions of the thoughts and minds of those who re-conquered Spain to Christian rule and advanced their banner to a new-found world, they are works of expressive art and grand dramatic power, and form a fitting climax to the growth of that art of which they are the final utterance.

DISCUSSION.

The CHAIRMAN, in opening the discussion, after alluding to the intense pleasure with which he was sure all present had listened to the author's eloquent description of the principal Spanish cathedrals, said he could not agree with all the conclusions at which Mr. Brewer had arrived, although he agreed with most of them. Many people contended that everything that was done in Spain was the work of foreigners. Personally, he had always held the opinion that the Spaniards were not an original nor inventive people, but purely an assimilative race, and, as a matter of fact, they had received from abroad the impetus and impulse in all their arts and industries, their literature, sculpture, painting, and architecture. But, although they were not naturally inventive, they were a people stirred by a very strong individuality, and were unquestionably adaptive. All the arts they received from others remained foreign for but a very short period of time, and almost at once the strong Spanish character invariably stamped its own influence on them. The author was therefore quite correct in his statement that no sooner was Gothic art received in its entirety from France and Germany, than the Spaniards, whilst keeping it alike, yet made it dissimilar. There was a reason for that running through the whole of their art and literature. They were a people with a strong concentrated individuality, but from the facts of their history they were naturally most devout. For centuries they struggled against the infidel for the possession of their soil, and as for centuries they were the weaker party, they had to appeal to the mysterious intervention of the Divine aid, the help of saints, and to miraculous swords that would deliver their conquerors into their hands. As a consequence, in the course of eight centuries they developed a type of religion and an outlook upon the world entirely different from that of France or Italy. Italian, and, to some extent, French art was strongly sensuous in its appeal. The Spaniard, however, had no sensuousness in his art; his was always an appeal to mystery, to romance. When what was wrongly called Gothic architecture first came to Spain in the eleventh century, it came as an addition to romanic architecture already existing, or in course of constrution like the cathedral at Tarragona, and the old Salamanca Cathedral, and it blended very harmoniously with that style. It was not until the thirteenth century that the full force of the French architectural influence was felt in the country. There were three cathedrals all practically contemporary one with the other, Burgos, Leon, and Toledo, all, as he contended, un-Spanish and unrepresentative of real Spanish feeling; in fact, entirely at war with the impression desired to be produced by pure Spaniards. There was a considerable Spanish impression made in the course of time even upon those great pure Gothic cathedrals, but they still remained

to some extent foreign in their appeal. Views had been shown of the crocketed spires of Burgos, of the extremely ornamental outside of the chapel, and of the central lantern over the crossing. Such crocketed spires would be seen hardly anywhere else in Spain. So far as he could see, it was a German cathedral, having been built by two Germans. Since it was built a considerable Spanish impress had, of course, been laid upon it; but, as it stood, outside it was a pure Gothic cathedral. The effect, however, was not a Spanish one. On going into the cathedral at Burgos one did not experience the feeling almost of fear at the enormous space, or the stupendous impending over-hanging grandeur of it all. One saw a lightsome cathedral, with the sun shining brightly through long, large lancet windows, and the church was comparatively a light one. Exactly the same remark applied to the cathedral at Leon. That cathedral had been under renovation for the last fifty years, and within the last few weeks the last piece of scaffolding had been taken down from the inside, so that he was able to say from a recent inspection of the building, that Leon Cathedral was now a perfect dream of sensuous loveliness. Street called it a pure French cathedral, a description with which he (the Chairman) did not agree, as he thought it was rather an Italian cathedral. Practically the whole of the walls, not only the main line of walls, but above and below and right round the two transepts, and the trascoro, were one mass of glowing, brilliant, scintillating stained glass, with the consequence that none of the mysterious feeling of oppression and devotional fear was experienced which was present in a purely Spanish cathedral. The vast roof looked as if it were held up by mere threads of stone between the glowing windows of the walls; and that never had represented the dominant feeling of Spaniards. The Spaniards were not very long in impressing their own feelings upon the art. In the first place, he did not believe that Gothic architecture was ever really fit to express a Spaniard's view, but, at all events, he made it as near as he could to represent his feelings, and that fact was seen in the later cathedrals. For instance, on entering the comparatively late cathedrals at Seville, Segovia, and new Salamanca, there was not the lightsome, sensuous appeal of brightness and beauty present. Outside there were great grave spaces of undecorated wall, which meant very little light within; there were gloriously ornamented doorways and a few windows, and inside the effect produced was of overwhelming grandeur and magnificence. With the inside almost dark, one caught here and there the glint of a small window upon a rich carving, or a beautiful piece of gilding or painting, and an effect of mystery was produced. The whole of the effect was not seen, and consequently one imagined things beyond sight which were more beautiful and grand than anything the human eye could see; whereas on entering Leon Cathedral, all that there was to be seen was seen immediately on entering the door. The effect produced by Spanish art was by an arrangement of shadow to suggest something infinitely greater than could be seen. But there was another adaptation made by the Spaniards which altered the character to some extent of the Gothic cathedrals. It was never any part of the plan of the original designers of the cathedrals to put the choir in the middle of the cathedral. Standing at the west door of a Gothic cathedral, the architect intended one to see a vista of branch-like lines which met together overhead, and, to do that, a clear uninterrupted vista was required. It was often said that the idea of a Gothic cathedral was that of a grove of trees, and to enjoy that the grove must be clear. But it was not part of the Spaniards' plan that the whole of the view should be obtained by one glance from the west door, and they therefore added magnificent choirs in the middle, which were really cathedrals within a cathedral. Those choirs were placed in the late fifteenth and sixteenth centuries, and they had added mystery, richness, and grandeur, while breaking up the vista which the original architects of the Gothic churches intended should be produced. Those magnificent choirs were full of splendid choir-stall carvings, and the later pieces were nearly all either the work of Flemish or German artists and their pupils. At all events, the cathedrals as they now stood were gems of Spanish art. That of Burgos was as fine as any in Europe of its kind; that of Seville was, in some respects, beyond anything in the world; while that of Leon was to be compared with Milan; and if, for no other reason, the journey to Spain, with all its discomforts, was well repaid by the inspection of some of those works of supreme art, of which the author had shown such beautiful pictures on the screen.

Mr. A. W. Rimington, R.B.A., said he was well acquainted with Spain, having travelled and sketched in that country for fourteen months on one occasion and five months on another, and he had also been over nearly all the ground the author had illustrated in such an interesting way in his paper. He fully agreed with Mr. Brewer that Spanish architects did develop a style of their own, and he thought too much had been made in the case of Spain, and also of other countries, of the influence of foreign art. Greece borrowed her forms to a large extent from Egypt and Persia, and precedent largely influenced every art; in fact, it was impossible to draw a sharp line of demarcation between the art of any two countries or two periods. He, therefore, thought it was a little unfair to Spain to urge so persistently the influence of French and German art on her architecture. Spanish architects, at any rate, know how to deal with light and shade in their own buildings in a way which must appeal to the eye and mind of every painter who had sketched in Spain. The magnificence of the buildings struck home to the innermost feelings of the artist. It was interesting to note the fact that many Spanish artists and painters, including

Velasquez, were remarkable for their strong feeling for light and shade—for the importance of large masses of dark contrasted with large masses of light. He could not altogether agree with what had been said as to Gothic art not being the proper means for the expression of Spanish ethical and religious feeling. The proof of it was in the buildings themselves. One felt that the buildings were really the expression of the Spanish character—of the love of mystery and the feeling for something higher and nobler than the common-places of every-day life. The elaborateness and delicacy of Spanish architecture had, he thought, been a little underrated by the Chairman. The sculptures referred to at the back of the choir at Burgos could hardly be excelled for beauty of design and delicacy of execution, and the same remark applied in many other cases With regard to early Spanish art, he had travelled through the greater part of the extreme north-west of Spain, where there was a good deal of Romanesque work which was little known. For instance, at Noya there was an extremely fine Romanesque church; there were also some fragments of early art, probably much earlier than the eleventh century; indeed, one writer stated that in all probability they dated from the fourth to the seventh century. That Gothic art showed distinct tendencies towards Romanesque. The bridges in the district were exceptionally fine, many of them having fine Gothic towers and beautiful shrines. Another feature of the country was the roadside and village crosses. He desired, in conclusion, to express on his own behalf and that of many friends their indebtedness to Mr. Brewer for his most interesting paper.

Mr. P. Newman, R.B.A., speaking as an artist. desired to add his thanks to Mr. Brewer for his eloquent paper. In addition to the great lesson learned from the beautiful sketches which had been shown, those who had travelled in Spain had learned another lesson from the remarks made by the Chairman. The art of different countries taught different lessons, and his short experience of Spanish travel and study of the churches of the country convinced him that the Chairman's statements were correct. Burgos Cathedral appealed to him exactly as it did to the Chairman. He thought Seville, Toledo, and other cathedrals proved that the Spaniard in his art wanted to arrive at breadth by masses of shade, a thing all artists tried to realise. Underlying the prettiness and sensuousness of that ornamentation there was an essential gravity, without which most art failed. He thought the Spaniard had arrived at a sense of magnificence in art mainly by dealing with the buildings with the reserve and sobriety which he had shown. There was no doubt that Burgos Cathedral was crocketed and suggestive of German work, but Spain was a country whose art sprang from many origins, and he could not look upon Burgos Cathedral as a type of Spanish art in the same way that he looked upon Seville and Toledo.

The Chairman conveyed, on behalf of the audience, their thanks to the author for his excellent paper.

Mr. Brewer, in reply, having thanked those present for the appreciative manner in which his paper had been received, said he wished to emphasise the point more strongly than he did in the paper, that whether Spain developed a Gothic art or not, she developed an atmosphere in her churches which no other country had ever developed to the same extent. Since the commencement of the present century, the art of the future was the art of atmosphere. The man who introduced atmosphere in his picture, or novel, or anything else, would be the man who would rise; and that treatment of atmosphere in architecture could be studied better in Spain than in other country in the world. Whether the Spaniards were origina or not in Gothic architecture, they were original in the way in which they designed their buildings, and massed their light and shade, and therefore their art would always stand equal with any Gothic art in the world.

THE RAILWAYS OF THE UNITED KINGDOM.

There is general agreement that the present position of the British railway industry leaves much to be desired. Since the early days of railways, that is to say, during the last seventy years, the population of this country has increased by more than 50 per cent., its trade is six times greater, its wealth has quadrupled. In other countries there has been similar increase in population, wealth, and trade, but whereas on the Continent the increased traffic consequent upon these changes has brought greatly improved services, and much lower rates and fares, in this country the greater portion of the passengers have to pay much what they paid fifty years ago, and the rates for most of the freight traffic have not been lowered. In these circumstances the natural presumption would be that the shareholders in railway companies have gained enormously, that whilst the public have suffered they at least have enjoyed big and ever increasing dividends. But the contrary is the fact. Whilst the earning power of the locomotive has greatly increased its dividend earning power has steadily decreased. A reference to a Blue-book issued by the Board of Trade will show that the railway shareholder is receiving no dividend whatever on a steadily increasing proportion of his capital. Between £80,000,000 and £90,000,000 sterling is at present invested in railway stock in the United Kingdom which pays no dividend at all. Between £500,000,000 and £600,000 000

sterling, or nearly half the total amount of capital invested in British railways, is returning an annual dividend of 2 per cent. For the rest, it may safely be said that the very moderate dividend paid in no way represents the earning power of the locomotive.

How is this state of things to be explained? Why is it that the growth in the volume and density of traffic has not meant more rapid and frequent services of trains, lower freight rates and passenger fares, and higher returns upon the capital expended? Sir George Gibb would seem to attribute much of the failure to State control. In the paper recently read by him at the meeting of the Royal Economic Society he pointed out that the policy of this country in the past has been based upon "competition and control," and that the "inevitable weakness of the dual system of competition and control is that control checks competition just where it would be useful in the public interest, and competition nullifies control just where it could be advantageously applied." But granted that the policy of competition and control has been a failure, it does not fully explain the present lamentable condition of the railway industry. The railway authorities have another explanation upon which they are fond of insisting. They point to the rise in the percentage of working expenses (during the period under review) to gross receipts, which they put as from 47 per cent. to 63 per cent. They say that this rise has not only neutralised any gain made by improvement in machinery, and growing population, trade, and wealth, but has, in addition, absorbed an increase of 10 per cent. of gross receipts, and they attribute this increase in working expenses to increase in rates and taxes, and the demands of labour. But this explanation leaves much unexplained. British railways have, of course, been handicapped from the outset by legal and Parliamentary expenses, amounting to an average of £5,000 a mile, and, in one instance to £14,000 a mile, an outlay necessary to purchase the right to acquire land at a price far in advance of its market value. Rates and taxes have, no doubt, increased very considerably, and labour is more expensive than it was, but these are conditions of working certain not to be changed in the direction of lessening charges. If there is to be improvement in the position, it must be effected by other means, it must be sought in sounder management.

British railway management is archaic. The reforms needed are scientific and economic, rather than legislative. What do the Board of Trade railway returns show? That, on an average, a railway goods wagon is mobile on the track for only 52½ minutes out of 24 hours; that during the 52½ minutes, it journeys an average distance of 17⅞ miles, and that it only carries an average load of two tons. It follows that 3½ per cent. of its time is devoted to travelling at the moderate speed of 20 miles an hour, and that 96½ per cent. of its time is absorbed by detention during loading, unloading, and shunting. Moreover, as on an average it only carries two tons, or one-fifth of the load it is constructed to carry, the inference is that during its brief percentage of activity it, as often as not, travels empty. Can this state of things be defended? It is true that the Government official who is responsible for the figures quoted is of the opinion that "railway arrangements are excellent," but he can hardly have remembered his own figures when subscribing to this unqualified eulogy. They go far to explain why the volume of unremunerative railway stock increased from £80,000,000 to £85,000,000 between 1905 and 1906. While there are only some 38,000 miles of railway track in the United Kingdom (*i.e.*, equal to 19,000 miles of double track), there are no less than 14,000 miles of sidings. The railway companies admit the extravagance, but deny their responsibility for the undue detention of the railway wagon. They put the responsibility upon the consignee of the goods who, they say, detains the railway wagon, and uses it as a warehouse until he actually requires to handle its contents. The consignee does not deny it, but explains that his only reason for ordering goods to be delivered before he requires them is that he cannot rely upon punctual and prompt delivery, and is, therefore, obliged, in self-protection, to anticipate his requirements. Thus one waste leads to another. Not only is the wagon detained but the capital value represented by its contents is kept lying idle. The truth is that the railway companies have no efficient method of marshalling, loading, unloading, and clearing goods consigned to them for delivery.

The difficulty of quickly "berthing" goods trains on arrival at a terminus is acknowledged by the railway companies, but they have made no scientific attempt to cope with it. Instead of taking measures to unload, reload and despatch their wagons rapidly, and thus clear the way for new arrivals on the same siding, they are constantly adding to the number and length of their sidings. And the so-called "Goods station"? A typical goods station is a wilderness of sidings, perhaps a mile long and a quarter to half a mile broad. Loosely congregated sheds are dotted over it higgledy-piggledy from one end to the other. It is without design and too unwieldly and scattered to admit of the rapid intercommunication of parts essential to a building designed for a place of exchange, and it is devoid of any equipment other than a primitive crane. The original shed erected in early days is still standing. It has been enlarged. Its platforms have been lengthened. Auxiliary sheds have been erected in varying and irregular proximity to it, a certain general resemblance in contour alone establishing their relationship. These are practically the only changes that have been made. If one shed has been found insufficient, another has been built. If a platform was 600 feet long, it has been made 1,200 feet long. Consequently twice the time is required to traverse the platform, and this enlarged area of goods stations partly explains the enlarged percentage of working expenses to

gross receipts. In the matter of goods stations the present generation of directors have simply copied from the road carriers of a bygone generation, as their predecessors did before them.

What is the process by which goods are in the present day transferred from a road van to a railway wagon, or *vice versâ*? A cart, having collected a load of miscellaneous goods, carries it to the railway goods station where it is unloaded, article by article. Each article is confided to an individual called a "trucker," who puts it on the vehicle from which he takes his name, and starts on a voyage of discovery with it. Having, after much search, found the particular railway wagon destined to proceed to the railway station corresponding to the address on the parcel, he sets it down, and starts on his return journey to the cart, and the process is repeated until the job is complete. The average length of a trucker's journey is about 1,200 feet, but in those cases where he is delayed by obstruction a single journey may take him half an hour. Such an arrangement is archaic, and must become more unsuitable with every enlargement of the goods station. What is wanted is not enlargement but a suitably-designed and properly equipped building. It is believed that in such a building, a day's work by the present method could be performed in under an hour, on a tenth of the space now occupied. Be that as it may, the system of gradually loading up vehicles and thus detaining them, standing in the goods station for from twelve to seventeen hours at a time is indefensible. It means waste of time, space, rolling stock, and labour.

Maladministration is not confined to the goods traffic. It is to be found throughout the railway system. The majority of the directors are not experts in the business, and consequently are compelled to rely overmuch upon the managers, and the loss due from misdirection does not affect them. Their emoluments remain untouched; it is the shareholders and the community who are the sufferers. Hitherto the public have had to put up with a dilatory and expensive monopolist transport service, but with the advent of the tramway and the motor omnibus, the monopoly is disappearing, and if the railways are to avoid worse ills than those which confront them, radical changes in administration will have to be made. Economy and efficiency will have to be sought for and reached so that shareholders and the public may derive those advantages they have the right to expect from the great growth in the volume and density of railway traffic.

HOME INDUSTRIES.

Earthquake Buildings.—It appears probable that the ruined Sicilian towns, or certain sections of some of them, will be rebuilt of reinforced concrete. This is a combination of steel or iron and concrete, one being used where the other is weak. It is highly important that the steel should be properly distributed through the concrete, and also that there should be a firm grip between the concrete and the steel, so that the two together may behave like one homogeneous body. Tests seem to show that clean, straight bars are sufficiently gripped by concrete without artificial aids, and that rusty or greasy metal will reduce the adhesion as in the case of paint applied to iron. Hitherto reinforced concrete has been used chiefly for large structures, such as warehouses, bridges, and chimneys. There have been several failures, said to be due to improper mixing and setting of the materials, and to the removal of the moulding boards before the concrete was sufficiently set. The strength of concrete is much affected by improper mixing, and this is an objection to the adoption of the material for small buildings. The average contractor is hardly qualified to make a proper concrete when strength is important. There is another and serious objection in the comparative cost of suitable moulds for small buildings unless these are of the plainest box type. As regards the cost of reinforced buildings as compared with those of brick and stone, it necessarily varies with the size and style of building, and still more depends upon the local cost of materials, which in the case of brick and stone varies largely. Then there is the question of the permanence of reinforced concrete buildings. It is necessary to be able to demolish inconvenient or useless buildings, as well as to render them earthquake-proof. The explanation of the ability of the reinforced concrete building to resist earthquake shocks is that there are no joints, where the binding force is mostly dead weight, with but very slight assistance from the mortar, which is really only a bedding material. When a building is violently shaken these mortar joints will probably open, since they cannot withstand a pull, but only pressure.

A Meat Boycott.—The quarrel between the meat traders and the farmers is growing more acute, and there seems little likelihood of the two sides coming to an agreement at the conferenee to be held at the beginning of February. Indeed, the conveners on both sides are letting it be known that the meeting will be little more than a formal one for the receipt of the report, whose purport is already known In certain parts of the country the meat traders are already buying meat with a warranty, and in other districts no warranty is required since there is no disease. The question at issue is beset with difficulties, and the only really satisfactory solution of the problem would be the stamping out of tuberculosis. Is that beyond the power of the Board of Agriculture? Surely not.

German State Insurance.—The Gazette of the German Imperial Insurance Department summarises the latest report on the German state insurance of workpeople against old age and invalidity, and the facts therein set out deserve the careful attention of people in this country where a similar experiment

will probably be tried if the present Government remains in office. Apparently it was not possible to ascertain how many persons were included within the scope of the German law last year, but a recent estimate places them at 14,000,000. The organisation which deals with this immense body of the public is supplied in 31 invalidity funds and ten other special funds established for such persons as the State railway servants. The ten special funds also control the insurance of seamen and their widows and orphans. In 1907 the number of insured workpeople was 656,000,000, representing a total of more than £8,000,000 in the case of the 31 funds, and an additional £750,000 was paid into the ten special funds. During the year 134,490 new persons were paid for the first time: of these cases 10,769 were old-age pensions to persons over 70, 11,537 were for cases of sickness of more than 26 weeks duration (up to that period the payments came from the sickness insurance funds), and 112,184 were for cases of more or less permanent invalidity. The annual average value of a pension was £8 6s. for invalidity, £8 6s. 3d. for sickness, and £8 1s. 9d. in the case of old-age; in addition the State makes a separate allowance of £2 10s. per pension. There were also many cases in which lump sums were paid in lieu of pensions.

Slipshod Methods of Business.—A well-known engineering firm has sent to the *Manchester Guardian* the following communication they have received "from a remote city in Siberia." Its complaint is to be found in numberless Consular reports, and it is to be feared that there is a good deal of substance in it. Says the writer:—"It is no little complaint that we have to make against English firms that they never send us sufficient particulars of the goods for which they quote, such as would enable us invariably to answer the questions of clients when they show that they are interested and will purchase. There is always something missing, either some vital dimension or power required, or weights, or illustrations—just as if they were gifted with second sight, and able to supply such information thereby. The writer has been hammering at this point, relative to English estimates, for the past ten years, and it is as bad now as ever. It is no wonder that we have to fall back on the German offers or let orders pass us, for the Germans have reduced estimating to an exact science; they supply the minutest details and information; they send a dozen views of what they offer, often fully dimensioned and with sections; no wonder their trade is always increasing and England's falling off. Please excuse what we say, but we lose many orders from want of full information, and feel it keenly."

Insurance Movements in 1908.—The past year will be memorable in the insurance world for the number of novel schemes relating to a variety of risks, not previously underwritten, initiated by responsible companies. The year showed a very marked tendency to include all existing schemes of insurance within a single company's sphere of operations, and most offices are now willing to undertake all classes of business. One noticeable feature of the year was the issuing of policies covering loss of profits through fire by most of the old-established companies who had previously held aloof from this risk. This insurance is generally based on the principle of indemnifying actual loss of profits instead of the method of taking a fixed percentage of the payment under the ordinary fire policy. There are few, if any, insurance companies which now restrict their operations to one important department. The development which enables companies to provide facilities for all possible requirements of clients in respect of insurance commends itself to common sense, and it is surprising that it has been so long delayed. The latest development is the issue by certain companies of combined policies providing against the risks of fire, burglary, and employers' liability by the payment of a single premium. The past year saw few changes in the constitution of insurance companies. There were no amalgamations between companies transacting a similar class of business, and with, perhaps, one or two exceptions, the year saw no new venture of importance.

Cotton Bills of Lading.—A large number of cotton firms have signed an agreement reasserting the fundamental principle of the Cotton Bills of Lading Conference resolution, namely, that the cotton itself must be actually delivered to the owners, captain, or authorised agent in the port of shipment. The Committee's ruling that a port bill of lading can only be issued for a vessel in port has caused some dissatisfaction, especially among the American coasting lines, who claimed that their steamers were not in port for a sufficient length of time to enable them to conform to it. In order to overcome this difficulty the Conference Committee has, after consulting the principal interests, decided to create a new form of bill of lading, which is called a "custody" bill of lading. This may be issued after proper delivery of the cotton, but before the arrival of the vessel in port; but it is stipulated that within three weeks of the date of such bill of lading a master's (or agent's) receipt is to be given proving the actual shipments of the cotton. A "custody" bill of lading must be clearly marked as such, so that it may be distinguished from a port bill of lading, and both must, if signed by agents, bear the words, "By authority of the owners." These "custody" bills of lading can only be issued by shipowners, or regular loading agents who have signed the letter of agreement, so that a "custody" bill of lading should be a good collateral security, since it clearly establishes the responsibility of the owners of the vessel. It will also do away with the many newly-invented bills of lading, especially with the through bill of lading issued by a railway company in the port and signed

for cotton actually arrived in that port. The Conference Committee are confident that the "custody" bill of lading will prove acceptable to importers and spinners as a practical solution of existing difficulties.

The Shipbuilding Agreement. — All who are interested in the shipbuilding industry in this country must welcome the agreement provisionally signed by the representatives of employers and men in the shipbuilding trade, and intended to strengthen the guarantees for the avoidance of strikes and lock-outs. It comprises both the shipbuilders and ship repairers all over the country, and 26 trade unions on the other side. Under the agreement no steps towards an alteration in wages can be taken until after a lapse of six calendar months from the date of the previous general fluctuation. Before an application for an alteration can be made there must be a preliminary conference between the Federation and the unions to discuss the position generally. Within 14 days after the receipt of an application the parties must meet in conference. Any general fluctuations in tradesmen's rates shall be for piece-work 5 per cent., and for time work 1s. per week, or ½d. per hour. Where there is a dispute, the workmen, or deputation of workmen, shall be received by their employers in the yard at the place where the question has arisen for mutual discussion. Failing arrangement, there may be a meeting between the employers, with or without an official of the local institution on the one hand, and the official delegate or other official of the workmen concerned, with or without the workman or workmen directly concerned, as may be deemed necessary. Failing settlement in this second conference, the question is to be referred to a joint committee consisting of three employers and three representatives of the union, or of each of the unions, directly concerned, none of whom shall be connected with the yard or dock where the dispute has arisen. Failing settlement in this case, the question is to be brought before the employers' local association and the responsible local representatives of the union or unions directly concerned in local conference. Again failing settlement, either party may refer the question to a central conference to be held between the Executive Board of the Federation and representatives of the union or unions directly concerned, such representatives to have executive power. Finally, either party may, prior to stoppage of work, refer the dispute for final settlement to a grand conference to be held between the Federation and all the unions which are parties to the agreement. The agreement provides for almost every possible case of dispute, and it covers disputes about piecework, which are to be dealt with by a joint committee, none of the members of which has any personal interest in the yard where the dispute has occurred. The agreement goes very far to perfect the machinery of legislation, and should make strikes and lock-outs in the shipbuilding industry almost, if not altogether, a thing of the past.

OBITUARY.

FRANCIS ELGAR, LL.D., F.R.S.—The Society and its Council have sustained a severe loss by the sudden death of Dr. Francis Elgar at Monte Carlo, on the 17th of this month. Through his death the country is the poorer by the loss of one of the best of the modern school of naval architects, men who combine scientific knowledge with the practical experience that is essential to the due application of scientific principles. Born at Portsmouth in 1845, and associated in his earliest years with the dockyard, after passing through a course of instruction at the Royal School of Naval Architecture and Engineering, of which he was one of the first students, he entered the Government service in 1867. In 1871 he left to join Sir Edward Reed as his chief assistant on Sir Edward's retirement from the office of Chief Constructor of the Navy. In 1879 he was appointed Adviser on Naval Construction to the Government of Japan; and, after staying in that country for about two years, he returned to London, and started practice as a Consulting Naval Architect. Two years later, in 1883, he was appointed to the Professorship of Naval Architecture at Glasgow University, founded in memory of John Elder. But after holding the post for three years he returned to the Admiralty, and was appointed Director of Dockyards. In this capacity he undertook the task of reorganising the dockyards at home and in the Colonies. In 1892 he abandoned official life on his appointment on the board of the Fairfield Shipbuilding Company, to the service of which he devoted the remaining years of his life, becoming in 1907 Chairman of the company, and also Chairman of Messrs. Cammell, Laird, and Co., with which the Fairfield Company had close business relations.

His connection with the Society commenced in 1885 with the reading of a paper on "The Loadlines of Ships," under the presidency of his old friend, Sir Edward Reed. He became a member of the Society in 1889, and was elected on the Council in 1891. He was again elected in 1901, and served continuously, first as an ordinary member and then as a Vice-President, until the present date. On two occasions he took the chair at meetings of the Society, the last being in January, 1904, at the reading of the paper by Mr. Arthur Gulston on "Icebreakers." It was during his tenure of office that the Council acted as the Royal Commission for the Chicago Exhibition, and the very fine collection of ship models shown there was due mainly to the personal influence exerted by Dr. Elgar. He was an active member of the Institution of Naval Architects, and contributed many valuable papers to its transactions and to those of the Royal Society.

LORD AMHERST OF HACKNEY.—Lord Amherst of Hackney, who died in London, on the 16th inst., after a few hours illness, was in the 74th year of his

age. Educated at Eton and Christ Church, Oxford, he entered the House of Commons as a Conservative in 1880, sitting at first as the representative of West Norfolk, and as member for South-West Norfolk from 1885 to 1892, when he was raised to the Peerage. He was a Knight of Justice of the Order of Jerusalem, a Deputy-Lieutenant and Justice of the Peace for Middlesex, a Justice of the Peace for Westminster and Norfolk, and in 1866 he was High Sheriff of Norfolk.

For upwards of 50 years Lord Amherst was an enthusiastic collector of rare and interesting books and manuscripts, tapestries, antique furniture, and works of art. In particular, he possessed a magnificent series of Caxtons, most of the 17 examples being perfect. The greater portion of his library and art collection was sold recently under circumstances which are still fresh in the public memory.

Lord Amherst was one of the oldest members of the Royal Society of Arts, having been elected in 1867.

Lady Galton.—Lady Galton, of Himbleton Manor, Droitwich, and 12, Chester-street, S.W., who died on the 19th inst., will be greatly missed on her estate, for she was extremely charitable and generous towards her poor neighbours. She established there a workmen's club, and frequently arranged lectures and entertainments for the parishioners. Lady Galton only joined the Royal Society of Arts in 1907, but her interest in its work extended over a very long period, for her late husband, Sir Richard Galton, K.C.B., D.C.L., F.R.S., was an extremely active member, having served on the Council almost continuously for nearly 30 years, and having held the office of Chairman in 1886 and 1887.

GENERAL NOTES.

Andrew Carnegie Research Scholarship.—A research scholarship or scholarships, of such value as may appear expedient to the Council of the Iron and Steel Institute, will be awarded annually, irrespective of sex or nationality, on the recommendation of the Council. Candidates, who must be under thirty-five years of age, must apply on a special form before the end of February to the secretary of the institute, 28, Victoria-street, S.W. The object of this scheme of scholarships is to enable students, who have passed through a college curriculum or have been trained in industrial establishments, to conduct researches in the metallurgy of iron and steel and allied subjects, with the view of aiding its advance or its application to industry. The appointment to a scholarship shall be for one year, but the Council may at their discretion renew the scholarship for a further period instead of proceeding to a new election.

The Chemistry of Metal Working and Enamelling.—A course of five lectures on this subject is being delivered at the London County Council Central School of Arts and Crafts, Southampton-row, W.C., by Noel Heaton, B.Sc., F.C.S., on consecutive Wednesday evenings, at 8 p.m. The course began on January 13th. The general aim of these lectures is to supply the student with an explanation of the various methods of working found necessary in the practice of his craft, based on the chemical and physical properties of the metals and their alloys and other materials used by him. The lectures are illustrated by experiments and demonstrations, and also by visits to museums and works.

Panama Canal.—The Paris edition of the *New York Herald* recently stated that M. Bunau-Varilla has expressed his willingness to proceed to America and explain to the members of the New York Chamber of Commerce his misgivings with regard to the plan upon which the Panama Canal is now being built. In his opinion "open and deep junction between the oceans, free from any locks and works of art," is the only type of canal which is likely to be in any degree immune from the effects of earthquake shocks, as well as entirely free from any limitation of the size of ships or bulk of traffic. M. Bunau-Varilla considers not only that the low level waterway is perfectly practical, but also that a lock canal would be obsolete before it was completed, and in support of this contention he adduces the views of Mr. Hunter, the chief engineer of the Manchester Ship Canal, who is described as having expressed himself against the locks at Panama on account of his own unfavourable experiences in connection with the Manchester waterway. The question of deepening the canal in accordance with the increased size and draught of shipping, M. Bunau-Varilla regards as in process of solution, thanks to cheap methods of dredging, such as are used in the Suez and Manchester Canals. M. Bunau-Varilla's views are fully set out in the paper which he read to the Society in January, 1907, on "The Panama Canal—the 'Lock Canal' Type and the 'Straits of Panama' Type." (See *Journal*, January 25, 1907.)

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

January 27.—"The Part played by Vermin in the Spread of Disease." By James Cantlie, M.A., M.B., C.M., F.R.C.S., D.P.H. Sir Malcolm Morris, K.C.V.O., will preside.

February 3.—"The Problem of Unemployment." By Bolton Smart (Superintendent of the Hollesley Bay Labour Colony, Suffolk). Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., will preside.

FEBRUARY 10.—"Bosnia and Herzegovina." By ARCHIBALD R. COLQUHOUN, F.R.G.S., M.Inst.C.E.

FEBRUARY 17.—"The Commercial Relations of France and Great Britain." By MONSIEUR YVES GUYOT. SIR ROBERT GIFFEN, K.C.B., F.R.S., LL.D., will preside.

Dates to be hereafter announced:—

"Railway Development in China." By ARTHUR JOHN BARRY, M.Inst.C.E.

"The Application of the Microscope to the Study of Metals." By WALTER ROSENHAIN.

"The Resources of Peru." By C. REGINALD ENOCK, F.R.G.S.

"Afforestation and Timber Planting in Great Britain and Ireland." By. J NISBET.

"Hand-made Papers." By CLAYTON BEADLE and HENRY P. STEVENS, M.A., Ph.D.

"The Foundations of Stained Glass Work." By NOEL HEATON, B.Sc., F.C.S.

"Furniture Design and Construction, Ancient and Modern." By PERCY A. WELLS.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

FEBRUARY 25.—"The Buddhist and Hindu Architecture of India." By ARTHUR ANTHONY MACDONELL, M.A., Ph.D., F.B.A., Boden Professor of Sanskrit, University of Oxford.

MARCH 25.—

APRIL 29.—"The Problem of Indian Labour Supply." By SELWYN HOWE FREMANTLE, I.C.S.

MAY 27.—"The Function of Schools of Art in India." By CECIL L. BURNS, Principal of the Bombay School of Art.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

FEBRUARY 2.—"The Production of Wheat in the British Empire." By ALBERT E. HUMPHRIES, Chairman of the Home-Grown Wheat Committee. The Rt. Hon. EARL CARRINGTON, K.G., G.C.M.G., will preside.

MARCH 16.—"The Colonial Wool Trade." By S. BANKS HOLLINGS.

APRIL 6.—"Ceylon: its Industries and Material Progress." By the Hon. JOHN FERGUSON, C.M.G. The Rt. Hon. SIR WEST RIDGWAY, G.C.B., G.C.M.G., K.C.S.I., will preside.

MAY 4.—

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

G. L. ADDENBROOKE, M.I.E.E., "The Public Supply of Electric Power in the United Kingdom." Three Lectures.

LECTURE II.—JANUARY 25.—The working costs of power supply undertakings of different sizes and the prices at which they can supply energy—The modern power station.

LECTURE III.—FEBRUARY 1.—The distribution of electric energy at high pressure—Electric energy at the consumers—The development of electric power supply in the United Kingdom—Some observations on the legal position and on the relations of public and private enterprise.

LEON GASTER, A.M.I.E.E., "Methods of Artificial Illumination." Four Lectures.

February 15, 22, March 1, 8.

GEORGE GERALD STONEY, M.Inst.C.E., "Steam Turbines." Three Lectures.

March 22, 29, April 5.

F. W. LANCHESTER, "Aerial Flight." Three Lectures.

April 26, May 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 25...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. G. L. Addenbrooke, "The Public Supply of Electric Power in the United Kingdom." (Lecture II.)

Geographical, Burlington gardens, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. C. Welch, "London's Place in History."

TUESDAY, JAN. 26...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Karl Pearson, "Albinism in Man." (Lecture II.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Photographic, 66, Russell-square, W.C., 8 p.m. Paper by Mr. Chapman Jones.

WEDNESDAY, JAN. 27...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Ordinary Meeting.) Dr. James Cantlie, "The Part Played by Vermin in the Spread of Disease."

THURSDAY, JAN. 28...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Child Study Society, Parkes Museum, Margaret-street, W., 8 p.m. Discussion on the Report of the Royal Commission on the Care and Control of the Feeble Minded.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. H. W. Davies, "The Problem of Setting Words to Music."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. J. O. Arnold, "Mysteries of Metals." (Lecture II.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Dr. E. Rosenberg, "The Parallel Operation of Alternators."

FRIDAY, JAN. 29...Royal Institution, Albemarle-street, W., 9 p.m. Colonel Sir Frederick Nathan, "Improvements in the Production and Application of Guncotton and Nitro Glycerine."

North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, 7½ p.m.

SATURDAY, JAN. 30...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Sir Hubert von Herkomer, "Sight and Seeing."

CORRECTION.—The writer of "Arts and Crafts" in last week's issue regrets that it was stated on page 181, col. 2, line 26, that the new Design Club is housed in Berners-street. The correct address is 22, Newman-street, W.

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FRIDAY, JANUARY 29, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 1st, 8 p.m. (Cantor Lecture.) G. L. ADDENBROOKE, M.I.E.E., "The Public Supply of Electric Power in the United Kingdom." (Lecture III.)

TUESDAY, FEBRUARY 2nd, 4.30 p.m. (Colonial Section.) ALBERT E. HUMPHRIES (Chairman of the Home-Grown Wheat Committee), "The Production of Wheat in the British Empire."

WEDNESDAY, FEBRUARY 3rd, 8 p.m. (Ordinary Meeting.) BOLTON SMART (Superintendent of the Hollesley Bay Labour Colony, Suffolk), "The Problem of Unemployment."

Further particulars of the Society's meetings will be found at the end of this number.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1s. 6d. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURE.

On Monday evening, January 25th, Mr. G. L. ADDENBROOKE, M.I.E.E., delivered the second lecture of his course on "The Public Supply of Electric Power in the United Kingdom."

The lectures will be published in the *Journal* during the summer recess.

SEVENTH ORDINARY MEETING.

Wednesday, January 27, 1909; SIR HENRY TRUEMAN WOOD, M.A., Secretary of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Bauer, Charles, 72 and 74, Cannon-street, E.C.
Finsler, August, 9, Great Tower-street, E.C.
Hatch, John Newbery, Messrs. Hatch, Carter and Co., Tientsin, North China.
Hawksley, Charles W., 115, Fellows-road, N.W.
Jones, Arthur Edward, Assoc.M.Inst.C.E., Public Works Department, Eastern Bengal and Assam, Dacca, India.
Khoo Sian Tan, Chop "Khoo Chin Hong," Cecil-street, Singapore, Straits Settlement.
Piercy, Rev. William Coleman, M.A., 30, Markham-square, S.W.
Rider, Frank P., 181, Union-street, Southwark, S.W.
Robertson, Alexander Winton, Glencaise, Chalkwell-avenue, Westcliff-on-Sea, and Engine Works, Royal Albert Dry Docks, E.
Seeck, M., 6, Henrietta-street, Covent-garden, W.C.
Tonkin, Alfred James, 156, Strand, W.C.
Vernon, William Allen, Bohun-lodge, East Barnet, Herts.

The following candidates were balloted for and duly elected members of the Society:—

Agarwalla, Rai Girdhari Lal, B.A., 18, Edmondstone-road, Allahabad, U.P., India.
Avery, Thomas, M.Inst.N.A., R.I.M. Dockyard, Bombay, India.
Brown, Duncan Campbell, Bank of Scotland-house, Oban, N.B.
Deacon, Edward, Pentillie, Leopold-road, Wimbledon-park, S.W.
Drewry, Fred. W., Winnipeg, Manitoba, Canada.
Francis, Gabriel Joseph, P.W.D., Chindwin Division, Monywa, Burma, India.
Herringham, Mrs. Christiana, 40, Wimpole-street, W.
Höveler, Herbert Frederick, 45, Christchurch-road, Streatham-hill, S.W.

Leonard, Edward F., Amherst, Massachusetts, U.S.A.
Lomas, Harold M., Alcombe-Dunster R.S.O., Taunton.
Luce, Very Rev. Father Eugene, Clergy-house, Rangoon, Burma, India.
Monteath, John, Rajkot, Kathiawar, Bombay, India.
Rosse, Right Hon. The Earl of, The Castle, Birr, Ireland.
Slade, Frank, F.Z.S., The Horniman Museum, Forest-hill, S.E
Smith, Richard Tilden, Oaklands, Cavendish-road, Balham, S.W.
Townley, Charles Harry, 153, New Bond-street, W.
Right Hon. The Lord Mayor of London (Alderman Sir George Wyatt Truscott), Greatwood, Chislehurst, and 3, Suffolk-lane, E.C.

The CHAIRMAN announced that Sir Malcolm Morris, who was to have taken the chair, was prevented by the inclemency of the weather from being present.

The paper read was—

THE PART PLAYED BY VERMIN IN THE SPREAD OF DISEASE.

By JAMES CANTLIE,
M.A., M.B., C.M., F.R.C.S., D.P.H.

The part played by vermin in the spread of disease has only recently acquired a prominent place in the study of medicine. Certain knowledge we had. We were aware that a dog suffering from rabies caused hydrophobia in men, and could communicate the disease to other animals. We also knew that hydatids in the dog could be communicated to man, that trichina in the pig, the cause of measly pork, can infect the muscles of man; that the horse can infect man with glanders; and that small-pox was a disease associated with cattle. These and other ailments have long been known to be due to infection from domestic animals, and protection against these diseases was dealt with in a more or less empirical manner.

The new spirit of inquiry, however, which has arisen amongst us has led to a knowledge not only of the worm, bacterium, or bacillus which occur in these diseases, but also to an understanding why the parasites which cause these ailments should occur in both men and animals. The parasite itself has been studied —its mode of life, its development, and, chief feature of all, the necessity for its existence in, say, man and dog, in a mosquito and a man.

It is the last mentioned of these points which characterises the scientific inquiry of to-day. A study of the life history of the parasite has shown us that many parasites require two hosts; otherwise they die out; and it is chiefly to this branch of the subject I would claim your attention, for herein lies the key to many problems, and especially to the prevention of disease.

I wish to broaden the basis of study which the title of the Society might suggest, namely, "Incorporated Society for the Destruction of Vermin," and chiefly the rat; for until we get a grasp of the whole subject it is impossible to regard the matter from a rational point of view. To set to work to wage war against certain animals without knowing the why and wherefore of our action, will only lead to the formation of anti-extermination societies, and thereby to the detriment of the public health.

The establishment of the mosquito-malaria theory of Manson by Ross's work in India is the real starting point of modern knowlege of parasitology. Although it is called a theory, Manson had already proved the mosquito-filaria theory, namely, that the mosquito was an essential element in the life history of the filaria, and that for the development of the worm it had to pass a portion of its life in the mosquito and another portion of its life in man. The mosquito-malaria theory was a mere extension of a scientific fact already proved in the case of filaria, and the presumption of its truth in malaria was almost a foregone conclusion.

Let us turn then to a short study of the parasite of malaria, in order to understand why both man and the mosquito are necessary to its existence.

Malaria, or ague, as it is sometimes called, is due to a parasite which gains entrance to the red corpuscles of the blood. In these corpuscles it increases in size at the expense of the tissue of the corpuscle, and gradually undergoes development into spores, whilst it comes to occupy the whole area of the corpuscle. The corpuscle now ruptures, the spores or young parasites are scattered in the fluid of the blood, but soon they seek shelter in the substance of other red blood corpuscles, where they go through a similar state of growth.

In course of time, however, the processes of development and of infection of corpuscles

cease, and, were no provision made, the parasite would die out. The continuance of the species is, however, the primary object of every living thing, and the parasite has to provide for its continuance. This can only be done, however, by finding its way into the body of a mosquito where it undergoes a stage of development known as the sexual stage as distinct from the non-sexual stage in the human body. The sexual stage regenerates the parasite, fits it for further life in man, and so the cycle is completed. Here we have the key-note of the relation of animals to man in regard to disease: the passage from man to some extra-corporeal host, be it a dog, mosquito or insect, is necessary for the life of the parasite which in the order of nature has its future to provide for, as has the human being.

As with the malaria parasite, so with many others. Take the case of the filaria worm already mentioned. It is the cause of several troubles, the most prominent, however, being the condition termed elephantiasis, a disease met with in many tropical countries. It is found in districts where a particular form of mosquito is met with, and in these districts alone. For instance, in Barbadoes, where Barbadoes leg or elephantiasis is so common, a culex mosquito is present in large numbers. On the other hand there is no malaria in the island, and there are no anopheles mosquitoes which is essential to the spread of malaria.

There is an interesting phenomenon in connection with the spread of filaria. The commonest form of the worm is the *Filaria nocturna*, so called from the fact that the filaria only finds its way to the peripheral or surface blood during the night. It is during the night the mosquito bites, and the worm, as if endowed with the sense necessary for gaining access to the body of the mosquito, comes to the surface at a time when it knows the mosquito to be about. A further mark of what may be termed intelligence on the part of the filaria worm is that, although present in the proboscis of the mosquito, it will not leave that when the mosquite dips its proboscis into a banana, but will wait until the mosquito bites a warm-blooded animal.

A good example also of the spread of disease by mosquitos is yellow fever infection.

A worm which causes a great amount of physical incapacity is the guinea worm. In West Africa, many expeditions have been rendered difficult or futile by the troops or carriers engaged in the expedition being afflicted with guinea worm. As a rule this worm, a long animal—like a thread several feet in length—finds its its way to the legs; there it causes a small bleb, and should the man harbouring the parasite wade in water, the worm comes to the surface and sheds multitudes of young. The embryos must reach water; otherwise their continuance is impossible. Why is it necessary for them to escape into water? Not because of the water, but because it is necessary for their life cycle to gain access to a small cyclops which lives in the water, and in the body of which it is harboured for a time.

To prevent infection all that is necessary to be done is to filter the water ingested and thereby prevent the infected cyclops gaining access to the human body. A wonderful example of instinct or intelligence is manifested by this worm, for it will travel to any part of the human body where it has a chance of reaching water. In washermen it invades the arms, in water carriers the shoulders, and so on.

Plague in man is associated with rats, and the channel by which the bacillus of plague passes from the rat to man is the rat flea. Plague has not appeared in Europe to any extent for several centuries, and many attribute this to the disappearance of the black rat (*Mus Rattus*) from Northern and Western Europe. The black rat was driven out by the brown or Norwegian rat (*Mus Decumanus*), and it is held to be only the flea of the black rat that transmits plague.

So far as it is known the flea merely transmits the plague bacillus from the rat to man, an evolution process in the rat not being as yet proved.

The rat has been held from ancient times as the cause of disease, and has been and is shunned by mankind in all countries. Our dread of the rat as a mere animal is inexplicable, but in the light of a transmitter of disease the hatred of this rodent is readily understood.

Plague is perhaps the most abhorred of all diseases. Its deadliness and the time it persists in a country, once it gets hold, are sufficient to establish this dread. The design on many of the ancient coins, with figures in which the serpent is held aloft whilst a dead rat lies at the feet of the figure, is no doubt explained by the fact that the serpent is the enemy of the rat, and therefore potent in freeing the people from the rat scourge.

Trypanosomiasis, made very familiar to us lately under the name Sleeping Sickness, is a

disease caused by parasites, trypanosomes. Trypanosomes are present in the blood of rats in most countries, and these parasites pass from rat to rat by rat fleas or by the rat louse. Trypanosomes, although they do not seem to cause illness in the rat, are the cause of serious diseases in other animals. Surra, a disease of horses in India, is also due to a trypanosome, and seems to be conveyed by horse flies. Nagana, the name given to a disease of horses in South Africa, is also due to trypanosome, and is conveyed by the tsetse fly.

Dourine, a disease also of horses, in South America more particularly, is due to infection by a trypanosome. Cattle also in the Transvaal are afflicted with a trypanosome, which causes the glaziekte or bile sickness of that country.

In sleeping sickness the disease is transmitted by the tsetse fly, and the crocodile is believed to be the alternative host, the fly serving as a carrier only.

Ticks play an important part in the transmission of disease, African relapsing fever being due to a parasite (*spirochaeta*) conveyed by a tick. Lice, bugs, cockroaches, are all incriminated as transmitters of disease, leprosy perhaps being conveyed by lice, and several ailments by bed-bugs.

DISCUSSION.

The CHAIRMAN (Sir Henry Trueman Wood), in proposing a very hearty vote of thanks to the author for the brilliant exposition he had given of a most important and interesting subjeet, said he had noticed that, while Dr. Cantlie had demonstrated how diseases were disseminated by parasitic organisms, he had said nothing about the measures which might be taken for the eradication of the vermin which existed as the hosts of those organisms. That, he presumed, was to a large extent the province of the Society which had been established for the purpose, to the help of the officials and members of which the Royal Society of Arts owed the present paper. Further information on the economic side of the question was no doubt desirable. Those members who would have to rely on that condensed report in the *Journal* (and their number would be much larger than it would have been had the weather conditions been less unfavourable) would not be able to realise how clear and vivid had been the demonstration Dr. Cantlie had given them by word of mouth, or how excellent his illustration. As a layman, he naturally could not throw the light on the subject which Sir Malcolm Morris would have done; but at all events he could say that, amongst all the wonderful fairy tales of science to which the present generation of men had listened, there was hardly one more marvellous than that which recorded the result of the work of such men as Sir Patrick Manson, Major Ross, and Sir David Bruce. For thousands of years men had suffered from malaria, and for hundreds of years they had known that their cattle were destroyed if they passed through certain fly belts where the injurious insects abounded, but it was only within the last eight or ten years that the whole story had been traced out, so that the causes of malaria and many other kindred diseases were known with absolute certainty. He ventured to disagree with the author's statement that medical science was mainly occupied in discovering the reasons for the empirical knowledge collected by our forefathers, because it was well known that medical investigators were not content with finding out the reasons for existing knowledge and extending it, but they also made practical application of the knowledge which they gained. The knowledge which had been acquired about malaria was likely to render available for human life very large districts of the world which had hitherto been thought to be almost uninhabitable, at all events by the white races, and that was a very valuable practical result. In the same way it was common knowledge that the researches of men like Pasteur and others had enabled remedies for the diseases which they had investigated to be found, and he was certain that, as the years went on, further advance in that direction would be made, and many more remedies would be brought to light for different diseases, the causes of which were being so rapidly discovered.

The resolution of thanks having been carried,

Dr. CANTLIE, in reply, thanked the audience for the deep interest they had shown in the subject of the paper by attending the meeting on such a foggy night, and for the patient hearing he had been given. He hoped the Society for the Destruction of Vermin would not be looked upon as merely a society which advocated the mechanical destruction of vermin, but as a body of people who wished to study the possibility of certain vermin carrying diseases and why they did so. It was, he thought, unfair to one of the most beautiful sections of creation to call them abhorrent names—to praise up one animal and run down another. First of all, a parasitologist was required in connection with the society, so that if an outbreak of diphtheria occurred among some fowls or pigeons in Norfolk, he would be able to investigate the matter on the spot, and endeavour to ascertain whether inhabitants in the neighbourhood were suffering from the disease, and whether it was of the same character. A certain disease occurred amongst partridges in a certain part of the country. Some people might argue that those birds were only a rich man's pro-

vision, and not worth studying, but if their children were made ill owing to a disease prevalent in such game, the force of the argument was brought home to them. Similarly, in other cases, pigs had a disease, and the people in the locality had illness in consequence. The Local Government Board and the Board of Agriculture investigated such questions to a great extent, but the subject required studying from the verminous point of view by such a Society as had been inaugurated. The disease did not go direct from the animal to man, but through an insect of some kind; and it should be the endeavour of investigators to discover what it was, and stop it passing from the one to the other. If that could be done epidemics would be prevented, and the spreading of certain diseases would be controlled, as was already the case in other diseases which had ravaged the country. Medical men now knew what to do should typhus fever, plague, or cholera break out, and they were therefore no longer afraid of them, and he hoped in the future that other diseases which were ever present with them, would be similarly controlled. If a Chinaman was asked whether he had had small-pox, he said, "Not yet"; and if a mother in this country were asked whether her children had had measles, she gave exactly the same answer. Measles was the most despised disease in England, and yet it was responsible for a larger number of deaths than any other disease, entirely owing to the fault of the people themselves. He hoped that in the near future they would be able to stop such common diseases, in the same manner that some of the terrible epidemics, with which they were familiar, had been stamped out.

BOOKS ON WATER-MARKS.

It was intended to add a list of books on water-marking to Mr. Clayton Beadle's paper on the "Development of Water-marking in Hand-made and Machine-made Papers," read on May 16th, 1906 (see *Journal*, vol. liv., p. 683), but as the materials were not ready at that time it was necessary to postpone publication to a later date. Mr. R. A. Peddie, acting librarian of the St. Bride Foundation Technical Library, collected a series of titles, and was so good as to communicate them for the formation of a tentative bibliography. These titles, with others kindly communicated by the Keeper of the Printed Books, British Museum, and the Librarian of the Patent Office, are here printed, with the addition of some further titles.

Lists of books on water-marks are contained in C. M. Briquet's work, entitled "Papiers et Filigranes des Archives de Gênes" (1888), and in "Die Papiere des XIV. Jahrhunderts in Stadt Archive zu Frankfurt a.m. . . . . von Ernst Kirshuer (1893). These titles have been inserted in this list, with the names of the authority added.

The earlier English writers on this subject use the term *paper-marks*, but this word is not included in the new English dictionary.

1749. Joseph Ames's Typographical Antiquities. The first edition of this standard work was published at London in 1749. This contains on pp. 74-75 two plates of water-marks used by Caxton and other early English printers.

1776. Journal zur Kunstgeschicte und zur allgemeinen Litteratur, von Murr; tome ii., Nuremberg, 1776; tomes v. and xiii. (Briquet.)

1784. Joh. Gottl. Numan. Breitkopf. Versuch den Ursprung der Spielkarten, die Einführung des Linnenpapiers etc. zu erforschen. Leipzig. (Kirchner.)

1785. Joseph Ames and W. Herbert. Typographical Antiquities. 3 vols. 4to.

1787-1823. Sir John Fenn's edition of the Paston Letters. 5 vols., 4to. Vol. i. (1787), p. xxi., paper-marks as an authenticity of the age of the original paper of these letters. Vol. ii. (1787), at end, catalogue of Letters, with dates, autographs, and paper-marks. Plates viii., ix., paper-marks 1422-1460; plates x., xi., xii., paper-marks 1460-1483; plate xii., paper-marks 1483-1485. Vol. 3 (1789) Catalogue; plates xxi., xxii., paper-marks 1422-1460. Vol 4 (1789) Catalogue; plates xxvi., xxvii., paper-marks 1460-1483. Vol. 5 (1823), edited by Serjeant William Frere, Master of Downing College, Cambridge. Catalogue; plate xxxii., paper-marks 1460-1483; plate xxxiii., paper-marks 1485-1509. Mr. John Bruce, in his paper on the Authenticity of the Paston Letters (Archæologia, vol. 41), says of Fenn on page 22, "I believe I may say he was the first English antiquary who gave representations of these [water] marks and applied them as a test of antiquity."

1793. C. G. Schwartz. Opuscula quædam Academica varii Argumenti. Nuremberg. (Briquet.)

1795. Rev. Samuel Denne. Observations on papers; *in* Archæologia, vol. 12, 1795, pp. 114-131; contains four plates of miscellaneous paper-marks and one plate of Pott paper-marks from 1604 to 1663.

1797. G. Sardini. Esame sui principi della paucese ed italiana tipopafia Lucques. (Briquet.)

1799. Camus. Notice d'un livre imprimé à Bamberg eu 1462. Paris an vii. (three water-marks). (Briquet.)

1803. De La Serna Santander Catalogue des livres de sa Bibliotheque; tome v., Bruxelles au xi. (Briquet.)

1804. Gotthelf Fischer. Versuch die Papierzeichen als Kennzeichen der Alterthumskunde anzuwenden. *In* part 6 of his Beschreibung Typog. Letters. Nürnberg, 1804. 8vo. (St. Bride Foundation Technical Library.)

1808. Hendrik J. Jansen. Essai sur L'Origine de la Gravure en Bois et en taille-douce et sur la Connoissance des Estampes des xve et xvie siècles . . . Suivi de Recherches sur L'Origine du Papier de Coton et de Lin; sur la Calligraphie . . . sur les Miniatures des anciens manuscrits; sur les Filigranes des papiers des XIVe, XVe, et XVIe siècles . . . Paris, 1808. 2 vols. 8vo.

1814. S. Leigh Sotheby states that his father commenced to make a series of tracings of water-marks in this year. (British Museum Reading Room.)

1816. William Young Ottley refers in his History of Engraving to some water-marks in early printed books, and subsequently he made a Collection of Tracings of Water-marks. (See Sotheby's Principia Typographica, 1858, vol. 3, p. 4).

1816. Jacobus Koning. Verhandlung over den Oorsprong de Uitvinding Verbetering en Volmaking der Boekdrukkunst. Haarlem; 23 water-marks. (Briquet.)

1818. Jacobus Koning. Bijdragen tot de geschiedenis der Boekdrukkunst. *Harlem*; 10 water-marks. Koning was the first to point out the origin of some of the early water-marks.

1840. Samuel Leigh Sotheby. A collection of facsimiles of the water-marks used by the early paper-makers during the early part of the 14th and 15th centuries. London, 1840. Folio. (St. Bride Foundation Technical Library.)

1844. Hassler. Vertray über die älteste Geschichte der Fabrikation des Linnenpapiers. Verhandlungen des Vereins für Kunst und Alterthum in Ulm und Oberschwaben Ulm; 8 water-marks. (Briquet.)

1845. S. L. Sotheby. The typography of the 15th century: being specimens of the productions of the early continental printers, exemplified in a collection of facsimiles from 100 works, together with their water-marks. London, 1845. Folio. (British Museum, St. Bride Foundation Technical Library, Patent Office Library.)

1845. Friedrich Guntermann. Die älteste Geschichte der Fabrikation des Linnenpapiers. *Serapeum*, 1845. Nos. 17 and 18; 64 water-marks. (Kirchner, Briquet.)

1846. Sotzmann. Entgegnungen darauf. *Serapeum*, 1846. (Kirchner.)

1855. Illustrations of the British Paper Manufacture, containing specimens of Paper. Published by Messrs. Waterlow. 4 vols. Elephant folio. (Victoria and Albert Museum Art Library.)

1858. S. L. Sotheby. Principia Typographica. The block books issued in Holland, Flanders, and Germany, during the 15th century, considered in connection with the origin of printing; to which is added an attempt to elucidate the character of the paper-marks of the period. 3 vols. London, 1858. Folio. (British Museum Reading Room, St. Bride's Foundation Technical Library, Patent Office Library.)

1858. Joseph Hunter. Specimens of marks used by the early manufacturers of paper, as exhibited in documents in the public archives of England. In Archæologia. Vol. 37; 1858; pp. 447-454.

1858. De La Fons. Melicoeq Noms des diverses sortes de papiers, employés au Moyen age dans le Nord de la France, leurs prix, leurs marques, etc. Bulletin du Bouquiniste de A. Aubry, Paris; p. 482 et suiv. (Briquet.)

1858. Schuler von Libloy. Notizen zur Geschichte der deutschen Diplomatik in Siebenbürgen. Anzeiger für Kunde der deutschen Vorzeit. Nos. 11 and 12. (Briquet.)

1859. Vallet de Viriville. Notes pour servir à l'histoire du papier. *La Gazette des Beaux Arts.* 15 Mai, 1 Aout, and 1 Novembre; 91 water-marks. (Briquet.)

1860. H. Boyer and Vallet de Viriville. Filigranes de papier du 15 siècle aux armes des familles Cœur et de Bastard. Paris, 1860. 8vo.

1861. B. Hausmann. Die Wasserzeidren der Papiere dez Dureischen Kupferstiche Radirungen, Holzschnitte und Zeichmungen. Hannover. (Briquet, Kirchner.)

1863. G. Manzoni. Annali tipografici torinesi del secolo, xv. Miscellanea di Storia Italiana. Tomo iv. Turin; 33 water-marks. (Briquet.)

1861–63. William Blades. Life and Typography of Caxton. 2 vols. 8vo. 1861–2. Vol. 1, p. 51; vol. 2, p. xviii., plate 9.

1866. A. Rauter. Ueber die Wasserzeichen der ältesten Linnenpapiere in Schlesien. Sechster Bericht des Vereins für das Museum Schlesischer Alterthümer. Breslau; 173 water-marks. (St. Bride Foundation Technical Library.)

1866. E. Bodemann. Inkunabelu der königlichen Bibliothek zu Hannover; over 200 water-marks. (Briquet.)

1866. Weigel und Westermann. Die Aupïnge der Druckerkunst in Bild und Schrift au deren fruhesten Erzeugnissen in der Weigel's chen Sannubung Leipzig; about 100 water-marks. (Briquet.)

1868. Etienne Midoux and Auguste Matton. Étude sur les filigranes des papier employés en France aux 14e et 15e siècles. Paris, 1868. 8vo. (British Museum, St. Bride Foundation Technical Library, Patent Office Library.)

1870. D. Urbani. Segni di Cartière Antiche. Venezia. More than 150 water-marks. (Briquet.)

1871. A. Moschkan. Die Wasserzeichen auf der seit 1818 bis dato emittirten Briefmarken und Couverts nebst Abriss einer Geschichte der Briefmarkes und des Briefmarkensammelwesens. Dresden, 1871. 8vo.

1877. Ch. G. A. Schmidt. Mémoire sur les filigranes des papiers employés à Strasbourg de 1343 à 1525. Mulhouse, 1877. 8vo. *Bulletin de la Société Industrielle de Mulhouse*, November, 1877.

1877. F. Wibiral. L'Iconographie d'Antoine Van Dyck, d'après les recherches de H. Weber, Leipzig. (Kirchner, Briquet.)

1878. Desbarreaux - Bernard. Catalogue de la Bibliothèque de Toulouse 1ére partie, Monnable, Toulouse. (Briquet.)

1880. A. Claudin. Origines de l'Imprimerie à Alby en Languedoc, Paris (Briquet.)

1880. Quellen zur Geschichte Siebenbürgen's aus sächsischen Archiven. Ier Band Rechnungen aus dem Archiv der Stadt Hermannstadt und der sächsischen Nation, Ier Band. Hermannstadt. (Briquet.)

1880. A. Moschkan. Die Wasserzeichen auf Briefmarker, Couverts, Portkarten, etc., 4te Aufl. Leipzig, 1880. 8vo. (British Museum.)

1881. A. Zonghi. Le marche principale delle carte fabrianesi dal 1293 al 1599. Fabiano. (Briquet.)

1884. A. Zonghi. Le antiche carte fabrianesi alla Esposizione generale Italiana di Torino. Fano. (Briquet.)

1885. L. Marlet. Les Filigranes du Papier. Magasin pittoresque; 31 Janvier. (Briquet.)

1886. C. M. Briquet. Recherche sur les premiers papiers employés en Occident et en Orient du Xe au XIVe siècle. Paris. Mémoires de la Société Nationale des Antiquaires de France. Tome xlvi.

1888. C. M. Briquet. Papiers et Filigranes des archives de gênes, 1154 à 1700. Avec 593 Dessins, autographiés. Genève, 1888. 8vo. (British Museums St. Bride Foundation Technical Library.)

1888. C. M. Briquet. De l'utilité des filigranes du papier et de leur signification a propos d'un récent procés. Berne, 1888. 8vo. (British Museum, St. Bride Foundation Technical Library.)

1889. C. M. Briquet. De la valeur des filigranes du papier comme moyen de déterminer l'âge et la provenance de documents non datés. Genève, 1892. 8vo. (British Museum).

1889. N. Barone. Le filigrane delle antiche cartiere ne'documenti dell'archivis di stato in Napoli dal 13 al 14 secolo. (Napoli, 1889.) 8vo.

1889. William Blades. Water-marks. In the *Publisher's Weekly*. No. 907. 1889.

1890. P. H. Aitken. Preliminary note on 15th century water-marks. In *Trans. Glasgow Arch. Socy.* New Series. Vol. 1; 1890; pp. 535-539.

1891. Facsimiles of water-marks from the collection formed by the late Mr. R. Lemon, of the State Record Office, with illustrations from the earliest known examples. In H. T. Scott and S. Davey. A Guide to the collector of historical documents. London, 1891. 8vo. British Museum, 11899 h 36.

1893. Ernst Kirchner. Die Papiere des XIV. Jahrhunderts in Stadtarchive zu Frankfurt A. M. und deren Wasserveidren tedmisch Undersucht und beschrieben Von Ernst Kirchner. Mir 153 Abbildungen von Wasserzeichen. Frankfurt A. M., 1893. With a list of some books on the subject. (British Museum.)

1893. T. Piekosinski. Sredniowieczne znaki wodne zebrane zrekopisow. Wiek 14. Cracow, 1893. 4to. (British Museum.)

1893. L. Wiener. Etude sur les filigranes des papers lorrains. Nancy, 1893. 8vo.

1895. Miss E. E. Thoyts. Water-marks on paper. In the *Antiquary*, December, 1895.

1896. F. Keinz. Der Wasserzeichen der 14 Jahrhundert in Handschriften der kon. bayer. Hof- und Staatsbibliothek. München, 1896. 4to.

1896. Lewis Evans. Ancient Paper-making.

1898. A. Geyer. Registry of Water-marks and Trade-marks, compiled from the American paper trade. Second edition, New York, sq. 16mo. Fifth edition, 1903. (Patent Office Library.)

1899. N. P. Likhachev. Palæographical importance of water-marks. In Russian. 4 vol. and Atlas. St. Petersburg, 1899. 4to. and folio.

1900. Del Marmot (F. Baron). Dictionnaire de filigranes classés en groupes alphabétiques et chronologiques. Namur, 1900. 8vo. (British Museum.)

1902. Paul Heitz. Les filigranes des papiers contenus dans les archives de la ville de Strasbourg. Strasbourg, 1902. 4to. (British Museum.)

1903. P. Klemm. Papier Warenzeichen. . . Vom 1 Okt., 1894, bis ende 1902 für Klasse umfassend Papier, etc, eingatragenen Wort und Bildzeichen. Leipzig. Sur 8vo. (Patent Office Library.)

1903. P. Heitz. Les filigranes des papiers contenus dans les incunables Strasbourgois de la Bibliothéque Imperiale de Strasbourg. Strasbourg, 1903 4to. (St. Bride Foundation Technical Library.)

1904. P. Heitz. Les filigranes avec la crosse de Bâle. Strasbourg, 1904. 4to. (St. Bride Foundation Technical Library.)

1906. Harold Bayley. Notes on Water-marks. In the *Booklover's Magazine*. Vol. 6, pp. 65-71.

1907. C. M. Briquet. Les Filigranes: Dictionnaire des Marques du Papier dès leur Apparition vers 1282 jusqu'en 1600; avec 39 figures, dans le texte et 16,112 facsimilés de filigranes. Paris, 1907. 4 vols. 4to.

COLLECTIONS OF WATER-MARKED PAPERS.

A collection of specimens in tracing or facsimile of early printing; of tracings of early water-marks on paper, and of specimens of papers with water-marks, brought together, and illustrated with copious manuscript notes by Samuel and Samuel Leigh Sotheby. 31 volumes. Folio. (British Museum, *b* and *c*, and 319 *b*.)

Collection of nearly 500 facsimiles of the water-marks used by the early paper-makers, late 14th and early 15th centuries. Folio; 24 plates, some a little water stained. Original stiff paper wrappers. Leycester bookplate. 1840.

MEXICAN POTTERY.

The pottery industry of Mexico is of ancient origin, having been handed down from father to son from time immemorial. Excavations among the prehistoric ruins of Mitla have resulted in the unearthing of many specimens of this handicraft, the designs of which are reproduced to this day. Cuernavaca, Guadalajara, Puebla, and Oaxaca, are the principal centres of the modern pottery industry, although pottery is manufactured in many of the smaller towns and villages throughout the country. The pottery made in these cities possesses distinctive types and characteristics, each quite different from the others, and universally known and recognised by the name of the city where it is made. Cuernavaca pottery is

made in the little village of San Antone, just outside the city of that name. The dwellers in practically every one of the houses of the village are clay workers, and each house is a workshop. Pottery is here made by hand, and according to the Special Agent in Mexico of the United States Government, after the following process. The clay, having been taken from the earth, is first thoroughly dried in the sun, then pulverised with a wooden mallet, and passed through the finest meshed brass wire-cloth, after which process the clay is finer than wheat flour. The former custom of the Indians was to use a handkerchief, or a piece of cotton shirting for that purpose. For mixing, a fine slime is prepared by soaking a portion of the pulverised clay in water, passing it through a sieve, and afterwards mixing the dry clay, and kneading it to the right consistency. A mould of the required size for the body of the article to be made is placed on the upper portion of the old style potter's wheel, covered with the proper thickness of clay, then patted and shaped with a wooden paddle and with the hands. The Indian potter turns the model about before him by scraping his bare toes on the lower portion of the wheel, and during the revolutions he continues to smooth the clay with a narrow strip of wet cloth until the desired surface is obtained. The narrow standard or legs, as the case may be, are then fashioned, and the article removed from the mould and placed in the same inverted position until such time as the standard shall have dried sufficiently to hold the weight of the body. Handles, spouts, &c., are all formed by the hands, without moulds, and joined by means of the clay slime and prepared clay. One characteristic peculiar to the Cuernavaca pottery is the inlaid decoration, for which small pieces of broken china are employed. Other decorations principally used are moulded reptiles and insects, moulded leaves and flowers, and stamped work. The making of the inlaid work is a slow and primitive process, and the execution of the many and often elaborate effects thus wrought is a great tribute to the artistic and patient Indian potter. The design to be used is first drawn upon thin paper, then placed upon the damp clay and traced with a small sharp-pointed stick, after which it is slowly wrought by pressing bits of china of the proper shape into the clay, with the glazed surface on the outside. The article is then thoroughly smoothed with a wet cloth and placed in the drying-room. Moulds for the formation of the decorations are made in plaster of Paris from the live reptiles, insects, &c., so that each is perfect in detail. These decorations are made by carefully pressing the clay into the mould, and as carefully removing it. The edges are then trimmed, and the moulded decoration placed in the desired position on the article to be decorated, using the clay slime as a cement. In cutting portions of the clay preparatory to moulding, a crude tin knife is employed. For trimming edges a thread of fibre is used, one end being held in the mouth, the other in the hand. Stamps for fashioning the stamped decorations are made from hard wood, hand-carved by the Indians. During the drying process the pottery is carefully shielded from sun and wind, and a careful examination made each day of every piece in the drying-room, so that, if possible, the moulded decorations may be prevented from cracking. Should these crack before the articles are completely dried, it is possible to replace the decoration: otherwise the article is valueless. When drying, the handles and other delicate portions are wrapped in cloth, that the process may be equalised. At a certain time the moulded decorations are well scraped and cleaned, and, when thoroughly dry, the pottery is polished with a piece of rough sacking, and finally with a smooth cloth. It is now placed in the sun to be completely heated before painting and burning. One colour only is used in the painting of Cuernavaca pottery. This is a yellow clay from the neighbouring mountains, similar to yellow ochre, simply mixed with water. The pottery is now ready for burning. Here, again, are found the most primitive methods. It has been stated that the habits of the Indian potters, together with a natural antipathy towards progressive usages, almost prohibit the introduction of new tools or methods; in fact, the workers refuse to substitute certain modern tools purchased for the work, preferring their own crude ones. No permanent kiln is used for burning, each individual process being accompanied by the building of a kiln of the size required, in the following manner:—A number of jars, approximately eighteen inches in height and nine inches in diameter, are placed on an open space of ground as closely together as possible, between and around the outer edges of which is laid the fuel. Flat pieces of previously burned pottery are used to cover the jars and fuel, upon which are piled the articles to be burned. The whole is then completely covered with many "comales" (round, flat slabs which are used for cooking the "tortillas," a sort of pancake and universal food, by being placed over burning charcoal). The fuel is then set on fire, and when well alight, green grass or wet hay is thrown over the pile. The necessary burning occupies about two hours, after which time, and while red hot, the kiln is uncovered. Each article is removed, being lifted by an iron rod, and allowed to cool in the air, which concludes the process of manufacture. After burning, the painted portions of the pottery will have turned to a dark terra cotta, and the unpainted portions, or such pieces as are wholly left in the natural colour of the clay, will have changed from a dark grey to a light terra cotta colour. The form of the lizard, so frequently employed in decorations of this particular pottery, owes its use to the existence of a lizard, nearly nine feet long, carved on a rock, supposedly by the Aztecs, in the village of San Antone.

Pottery made in Guadalajara is probably more widely known than that of any other Mexican manufacture. The potteries are situated about six miles from the city proper, in the Indian village of San

Pedro. Here another race of potters, true descendants of the Aztecs, lives, handing down from one generation to another the knowledge of working the peculiar class of ware, called by them "Zapotecas." Many of the original forms and designs mentioned in the records of the friars, at the time of the conquest, are preserved in the Guadalajara pottery of to-day, this being especially true of the ware known as the "Aromatic" pottery, which is coloured in the burning. The clays from which the Guadalajara potteries are formed, are of two kinds — black and white. The black clay is found in veins, three to six feet below the general level of the ground, and is a formation of vegetable origin, as is proved by its peculiar odour, and also by petrified remains. The white clay is more abundant than the black, and is very compact and heavy, being a subsoil formation, covering large areas. The black clay is prepared by simply being dissolved in water, a proccess which produces a very sticky substance. The white clay is thoroughly dried, pulverised, and passed through a fine white sieve, then added to the wet black clay, and well kneaded. For moulding the finer forms, the potter uses the substance as thus prepared. Each family of workers specialises in its own line of work. Many forms and designs are produced, but only one design in one family. Unlike the Cuernavaca potters, the Guadalajara workers never use a potter's wheel. Here the small articles are made in moulds, and the larger pieces are formed by placing a mass of prepared clay on the ground, while the potter walks round and round the clay to be moulded, using a piece of hogskin well soaked, in water, for forming and smoothing the article. The tools which are employed are a piece of tin, or a knife rudely fashioned from this metal, a wire for cutting or trimming, and a nail or small piece of pointed wood never exceeding six inches in length. The Guadalajara ware is fired or burned in cylindrical ovens, with a hearth and no chimney, made especially for this purpose, different fuels being employed to produce the different colours. For red-coloured pottery, a grass locally known as "tepopote" is used, which is found in abundance on lands having a volcanic formation, and is in appearance much like pumice stone. Such lands are called by the natives "jal," and from their formation, it is said, the State takes its name of Jaliseo. When a greyish-white colour is desired, the pottery is burned with twigs ot "tarray" (tamarisk), or shavings may be used. It is impossible to employ wood or coal of any kind, as the necessary requirement is the flame rather than the heat. The burning process occupies about twelve hours, more or less, according to the size of the oven in use. The colours employed are mineral, manganese for the black, kaolin for the white, while the reds and yellows are of special kinds of clay. Water bottles, for instance, which are often made in red or yellow colourings, are first painted and then burned, painted while still warm, and again subjected to the flames of dried grass, which burns with much smoke. The bright greens, blues, &c., are obtained from pigments mixed with gum, varnish, or oil, and not being fired, these colours will in time wear off. The decorations or paintings, which are all of Indian origin, on Guadalajara pottery, very closely resemble Chinese decorations. The Puebla pottery is a more or less crude earthenware, having a white, or rather a greyish white ground, with decorations usually in the delft blue shapes, although browns and yellows sometimes appear. The Puebla tiles are a famous characteristic of the city of the same name; in fact, Purbla is a city of tiles. They are used everywhere—on the domes of churches, the façades of residences, and on walls and floors. The decorations are usually mediæval in design, and, though somewhat crude, no inartistic. Puebla ware is known as "Talavera." The pottery made in Oaxaca is a green glazed ware, and includes articles for table and kitchen use.

THE IMPERIAL INTERNATIONAL EXHIBITION.

The Times of the 22nd instant contains the following announcement:—

The Exhibition which will be opened in May next at Shepherd's-bush, on the site occupied last year by the Franco-British Exhibition, will be the first International Exhibition held in London for half a century.

The project of the Imperial International Exhibition has met with the warm reception which the advantages it holds out to all who take part in it most unquestionably deserve. The three Scandinavian kingdoms, Sweden, Denmark, and Norway, in addition to Holland, Persia, Turkey, and Rumania, have already decided upon occupying large areas; and the negotiations now proceeding with other countries in Europe, Asia, and America leave no doubt that Russia, Austria, Italy, Spain, and several other nations of the first importance will follow the example of those which have already decided to be represented. The exhibitors of the United Kingdom are already well to the fore, and there will be special sections for Scotland, Ireland, and Wales. There will be large and carefully selected exhibits of the leading firms from all portions of the British Isles. The purpose of the Exhibition will be to show only the best and choicest. The new science of "aviation" will be in evidence, and there will be a large exhibit of aeroplanes, steerable balloons, and other varieties of flying machines; whilst amongst the prominent features of the Exhibition will be three historical sections, a Palace of Light, in which will be portrayed the progress in the manufacture of artificial light from the days of the rush-light to those of the electric lamp; a most interesting exhibit showing the gradual development of automobiles; and a collection illustrating the changes that have taken place in musical instruments of all descriptions from the earliest times to the present day. The architectural and spectacular

features which did so much to ensure the success of the Franco-British Exhibition will be repeated, and several important and attractive novelties will be introduced, amongst others a Belvedere Pavillion in the Central Lagoon, which will produce a most novel and striking effect.

The musical arrangements will be much improved upon, and bands, military and civil, will be engaged from several European capitals.

One of the most important features will be the section devoted to health and pleasure resorts, the intention being to set before the public the attractions, both picturesque and hygienic, of the principal watering places of the world. The suggestion has been received with appreciation, not only from the United Kingdom, but from localities in France, Italy, Germany, Norway, Denmark, Switzerland, Holland, Spain, and Portugal. This department of the Exhibition cannot fail to have an important effect upon the future of the British health and pleasure resorts. To the foreign visitors to the Exhibition the natural charms of British resorts will be revealed, and, on the other hand, those identified with their management and prosperity will be able to learn useful lessons from a study of the methods adopted on the Continent.

SPECIAL COMMISSION ON CONCRETE AGGREGATES.

The Executive of the British Fire Prevention Committee have formed among the members of the Committee and representatives of the public authorities subscribing to the Committee a Special Commission on Concrete Aggregates, the scope of which is described in the following resolution :—"That having regard to the confusion existing as to concrete aggregates, and the absence of their exact specification, the British Fire Prevention Committee do hereby constitute from among its members and subscribers a Special Commission to report upon and define the aggregates suitable for concrete floors intended to be fire-resisting, having due regard to questions of strength, expansion, and the chemical constituents and changes of the aggregates." In forming the Commission it has been considered of importance that the various technical interests should as far as possible be represented. The work has been divided into two sections in charge of two Sub-committees, the one dealing with Research Work and Tests, and the other with Specifications. An interim report has just been issued in which it is stated that the euquiry necessitates tests being made over a period of years before final recommendations can be drafted, that a further interim report cannot be expected before 1910, and that a final report cannot be expected before 1912. In view of the heavy expenses entailed by the work contemplated, the Committee appeal for funds and facilities for carrying out the Researches and Tests which are considered necessary.

HOME INDUSTRIES.

State Afforestation.—The report of the Royal Commission appointed to inquire into certain questions affecting coast erosion and afforestation in the United Kingdom makes wide-reaching proposals with respect to the latter subject. The case for afforestation is a strong one. Our imports of timber in 1907—the latest year for which the figures are available—were valued at £32,326,117. Taking the more important classes of timber that we import from the Continent and America, the Board of Trade returns show that in 1907 we received 8,513,037 loads, valued at £20,127,943. The climate of the countries from which these supplies were obtained is of the same general character as our own, and the trees that are indigenous there can all thrive in the United Kingdom. Assuming an annual growth per acre of one ton or one load, it would take 9,000,000 acres of forest, wooded on a definite rotation, in addition to what we already possess, to yield the above-named quantity. The kind of land that would seem to be most suitable for afforestation is that which is classed in the agricultural returns as "rough mountain land used for grazing." Of this class there exist nearly 13,000,000 acres in Great Britain. In addition to this area there are in Scotland over 3,500,000 acres devoted to deer forests, giving altogether a total of more than 16,000,000 acres not under cultivation or permanent pasture. The classification of Ireland is somewhat difficult. The "grazed mountain land" amounts to nearly 2,453,899 acres, "barren mountain land" to 541,766 acres, and "bog and marsh" to 1,347,619 acres, a total amount of 4,343,284 acres. In both countries much lies above the altitude that determines the profitable limit of tree growth. The Commission have arrived at the conclusion that there is, including 6,000,000 acres in Scotland, an aggregate of 8,500,000 acres of afforestable land in Great Britain; to which may be added at least 500,000 acres in Ireland, making 9,000,000 acres in all. If these figures are approximately correct, it follows that there is sufficient suitable land in the United Kingdom to supply all the timber the country at present wants. But then it would require 80 years for the Commission's scheme of afforestation to mature.

The Commission's Report. — The Commission advise that the nation should gradually acquire by purchase these 9,000,000 acres of land, and spend during the next eighty years a sum of money which would amount in all to about £450,000,000 sterling. Afforestation represents a productive investment, and would have to be financed by a loan. The annual sum required for the Commission's full scheme is £2,000,000. The interest on the loan it is proposed to defray out of taxation. The net deficit is estimated at £90,000 in the first year, and it would rise progressively to £3,131,250 in the fortieth year, after which period the forests would become more than self supporting. After 80 years the revenue from the

at present prices—which promise to be materially enhanced—should be £17,500,000. This represents 3¾ per cent. on the net cost, calculated at accumulated compound interest of 3 per cent. Looked at from another point of view, the State would then have possession—assuming the Commission's estimates to be borne out by the result—of property worth £562,000,000, or £107,000,000 in excess of the total cost involved in its creation, calculated at 3 per cent. compound interest. The State is asked to spend £450,000,000 upon growing timber. Is it worth while doing so, and if the State can profitably incur this great outlay, why has the work been left undone by private enterprise?

Private Owners and the State.—To answer the last question first. The State can accomplish much that is beyond the power of the individual, and there are many good reasons why the private landowner will not spend large sums on expectation. In converting pastoral lands into forests the present returns must be sacrificed, and even if these be small, they are tangible and immediate. But this is not all. To create forests requires capital, and although this be forthcoming, its investment in tree planting must mean the disappearance of any immediate returns, and probably of any return whatever during the owner's life time. On a small scale a private landowner may be prepared to face this double loss, looking for his return in the pleasure that thriving woodlands confer. But no appreciable progress is ever likely to be made by private initiative in the afforestation of the wide extent of poor land which might be dealt with by the State. There remains the question whether what the individual landowner cannot reasonably be expected to do, the State—that is, the taxpayer—may profitably do. The strongest argument in favour of State afforestation is that it would go some way towards solving the problem of unemployed labour and rural depopulation. Most of the witnesses examined by the Commission were emphatic in maintaining that forestry promises to be a powerful agency in stemming the tide of rural depopulation, and in attracting back to the country men and families who have migrated to the towns. For example, Sir Bosdin Leech, late Lord Mayor of Manchester, and at present Chairman of the Waterworks Committee, who has charge of the work of afforestation on the catchment area at Thirlmere, was strongly of opinion that forest operations afford a very desirable means of keeping men in the country, and that they would in this way have a material effect on the unemployed problem in the towns. But irrefutable evidence was put before the Royal Commission that a considerable proportion of the workmen unemployed are, for one reason or another, unfit to undertake work of the nature of that under consideration. Some are physically unfit owing to ill-health, lack of development, injuries, and similar causes; others have become so morally deteriorated, or so lacking in determination, as to be incapable of persisting with any useful employment. Again, very many are temporarily unfit, either because they have been so long without a sufficiency of nourishment that they have fallen into a condition of physical weakness, or because their previous employment has been of a character to make immediate effective work with a spade impossible. But suitable men for the work are to be found in considerable numbers in all industrial centres, and a large proportion of them might be expected quite naturally to resume rural occupations. And the evidence before the Commission suggests that with but little or no preparation, and no excessive amount of supervision, they could satisfactorily perform the operation of planting.

The Number of Workmen Required.—The Commission conclude, upon the evidence submitted, that on a reasonable estimate 100 acres of forest land would be the maximum area needed to provide labour throughout the year for a single workman. This is the figure, too, that was arrived at by the Departmental Committee on British Forestry of 1902. At present by far the greater part of the land suitable for afforestation is utilised for the pasturage of sheep, or, to a small extent, of cattle and ponies. Neglecting all such land as lies above 1,500 feet, it was given in evidence that, as at present utilised, such land provides employment for one man on 1,000 to 2,000 acres. Even taking the lower figure, which is that adopted by the Forestry Committee of 1902, it means that land under forests can maintain ten times the population that finds a living under pastoral farming. Nor must it be forgotten that a large proportion of our timber imports reach us in a more or less advanced stage of manufacture. In the case, for instance, of fir, and excluding pit wood, the Board of Trade returns for 1907 show that out of a total value of £17,803,149, no less than £16,307,871 is accounted for in wood that is "sawn or split, planed or dressed," the comparatively small balance being in the form of hewn logs. The labour necessary to saw, split, plane, or dress over £16,000,000 worth of timber cannot be estimated with any degree of accuracy, but it manifestly represents the employment of a very large body of men. At the present time the great bulk of cheap paper is prepared from wood, which undergoes various mechanical and chemical processes, during which it is converted into "pulp," and finally into paper. The consumption of this material in Great Britain is enormous, our imports for 1907 approaching a value of £4,000,000, apart from what reached us in the form of manufactured paper, which aggregated nearly £6,000,000, though the latter was not necessarily all derived from wood. It is said that there are only two wood pulp mills in Great Britain, and these are entirely supplied by foreign wood. The opportunities for extension in this direction, and consequently in the employment of labour, are therefore very great, and this industry has the additional advantage of flourishing in rural districts.

The Financial Considerations.—It is hardly open to question that it would be to the advantage of the kingdom if afforestation were carried out on a large scale. The United Kingdom contains a relatively smaller area of land under trees than any country in Europe—England 5·3 per cent., Scotland 4·6, Wales 3·9, Ireland 1·5, as against Belgium 17·3, Germany 25·9, Hungary 27·5, Austria 32·6—and as a consequence we have become almost entirely dependent upon foreign supplies of timber for structural purposes. If foreign could be displaced by home supplies, the country would be the gainer in many ways. But there are, of course, obvious objections to the proposal of the Royal Commission that £450,000,000 should be raised for the purposes of afforestation, and that £2,000,000 or so a year for the next 80 years shall be borrowed for that purpose. Nor can it be safely assumed that the Commission are right in supposing that at the end of the 80 years the State would be "in possession of property worth £562 000,000, or about £107,000,000 in excess of the total cost involved in its creation." Estimates of this kind are apt to prove illusory, and the Commissioners themselves admit that the private owner cannot, as a rule, make a profit out of forestry. "In no circumstances do your Commissioners suggest that the State shall be expected to finance schemes of private afforestation by way of loan or otherwise. The security would not, in their opinion, in such cases be of a sufficiently substantial kind to warrant such action." Is it likely that the State would make a large profit where the individual owner seldom makes anything but a loss? It might do so, but it has still to be proven. All experience shows that expenditure on large public works almost invariably exceeds estimates. But probably it would be safe to say that in course of time afforestration, properly managed, would pay its way, without counting the indirect gains to the nation from an adequate home supply of timber.

CORRESPONDENCE.

THE RAILWAYS OF THE UNITED KINGDOM.

I have read with interest the article on "The Railways of the United Kingdom," on pages 194 to 196 of the current number of the *Journal*, and I enclose, with my compliments, a print of a paper* I read last month, from page 11 of which you will see that my views on accounts coincide with the general tenour of the article.

I have elsewhere expressed the opinion that it is not improbable many of the very small parcels at present conveyed by goods train are actually carried at a loss, and if the public want "grande vitesse" service for such small parcels, they should pay more. The charges, if judiciously increased, would hurt no one, and the increased revenue would in time actually enable the railway companies to reduce rates on consignments sent in, say, five ton lots and upwards. In this way tradesmen would find it to their advantage to move larger quantities at one time, and so the average load per truck would move upwards.

S. CHAPMAN.

January 25th, 1909.

* "American Methods of Railway Accounting," by Samuel Chapman. (Reprinted from the "Journal of the Royal Statistical Society," vol. lxxi, Part. iv., 31st December, 1908.)

GENERAL NOTES.

ROYAL BRITISH RADIUM INSTITUTE.—Much interest will be felt by scientific and medical men in the announcement that the King will shortly grant a Royal charter establishing a Royal British Radium Institute, which will have the double object of carrying out research work and conducting a medical department for the treatment of such cases as may benefit by the radium cure. Attention was recently drawn by Sir Frederick Treves, in a lecture which he delivered at the London Hospital, to the wonderful effects worked by this treatment in such diseases as rodent ulcer, &c., and he expressed a hope that it may eventually prove capable of overcoming cancer itself. His Majesty, it is understood, has taken the greatest personal interest in the organisation of the Institute, the establishment of which has been rendered possible by a munificent donation from Sir Ernest Cassel. The medical and chemical council will include Sir Frederick Treves, Sir William Ramsay, Professor Sir J. J. Thomson (Cambridge University), the Hon. J. R. Strutt, and Mr. Henry Morris (President of the Royal College of Surgeons, and hon. Treasurer of the Imperial Cancer Research Fund). In view of the demand for radium which will probably be set up by the new Institute, it becomes necessary that there should be an adequate supply for the purposes of British experts. Hitherto all the radium available has been imported from Bohemia, the only place where it has been manufactured; but steps have already been taken by a British syndicate to begin the manufacture in this country. Radium can be made in England as well as in the Tyrol, the pitchblende from which it is extracted being obtainable in Cornwall, and having regard to its wonderful properties, of which scientific men have as yet obtained only the barest knowledge, it is to be hoped in the public interest that means will shortly be found to make a material reduction in its present fabulous price.

THE PATENTS ACT, 1907.—There has been some recent correspondence in the *Times* as to the probable

effect of the revocation of certain patents on the ground of their not having been worked in the United Kingdom. The section was intended to encourage British industries, and was indeed welcomed as a Protectionist measure by the opponents of Free Trade. It is now urged that its probable result will be to encourage the manufacture of the patented article abroad and its importation into this country, it being improbable that manufacturers here will find it pay to produce it if the manufacture is unprotected by a patent. Thus the clause may now conscientiously be approved by Free Traders. Attention has also been drawn to the remarks made by the Comptroller, who in delivering his judgment, expressed the opinion that it was to the general advantage that the trade should be freed and the importer enabled to obtain the foreign manufactured goods readily. This doctrine, if carried to its legitimate conclusion, would seem to justify the abolition of patents entirely, and the revocation, not of an occasional patent, but of the Statute of Monopolies itself.

ART IN THE NEW IRISH UNIVERSITY.—Speaking recently at a meeting of the Arts and Crafts Society in Dublin—a body which has for its objects the promotion and improvement of the practice of the artistic handicrafts in Ireland—Count Plunkett pleaded for the recognition of art in the new University which is to be established in Ireland. There was no reason, he said, why Ireland should not, at the initiation of the National University, take to heart the lesson which England had already accepted, and, as Slade professorships were now established in the English Universities, at least they might have equivalent offices in the new University in Ireland. The schools of art throughout the country were doing good work, he added, and one of the best things they could do was to get into touch with bodies that had control of the expenditure of large sums of money in order to let them see that there was nothing of artistic quality that was required for the spiritual or temporal needs of the country that could not be admirably produced in Ireland. The production of these things would lift above poverty many craftsmen, and would also lift the body of the people, and so help on the development of those qualities which they could say without any unweening pride belonged especially to the Celtic people.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

FEBRUARY 3.—"The Problem of Unemployment." By BOLTON SMART (Superintendent of the Hollesley Bay Labour Colony, Suffolk). SIR STEUART COLVIN BAYLEY, K.C.S.I., C.I.E., will preside.

FEBRUARY 10.—"Bosnia and Herzegovina." By ARCHIBALD R. COLQUHOUN, F.R.G.S., M.Inst.C.E. COL. SIR COLIN CAMPBELL SCOTT-MONCRIEFF, K.C.S.I., K.C.M.G., will preside.

FEBRUARY 17.—"The Commercial Relations of France and Great Britain." By MONSIEUR YVES GUYOT. SIR ROBERT GIFFEN, K.C.B., F.R.S., LL.D., will preside.

Dates to be hereafter announced:—

"Railway Development in China." By ARTHUR JOHN BARRY, M.Inst.C.E.

"The Application of the Microscope to the Study of Metals." By WALTER ROSENHAIN.

"The Resources of Peru." By C. REGINALD ENOCK, F.R.G.S.

"Afforestation and Timber Planting in Great Britain and Ireland." By J NISBET.

"Hand-made Papers of Different Periods." By CLAYTON BEADLE and HENRY P. STEVENS, M.A., Ph.D., F.I.C.

"The Foundations of Stained Glass Work." By NOEL HEATON, B.Sc., F.C.S.

"The Manufacture of Nitrate of Lime." By SAM EYDE.

"The Teaching of Design." By E. COOKE.

"Furniture Design and Construction—Ancient and Modern." By PERCY A. WELLS.

"Dewponds." By GEORGE HUBBARD, F.S.A., F.R.I.B.A.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

FEBRUARY 25.—"The Buddhist and Hindu Architecture of India." By ARTHUR ANTHONY MACDONELL, M.A., Ph.D., F.B.A., Boden Professor of Sanskrit, University of Oxford.

APRIL 29.—"The Problem of Indian Labour Supply." By SELWYN HOWE FREMANTLE, I.C.S.

MAY 27.—"The Function of Schools of Art in India." By CECIL L. BURNS, Principal of the Bombay School of Art.

Date to be hereafter announced:—

"Some Phases of Hinduism." By KRISHNA GOBINDA GUPTA (Member of the Council of India).

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

FEBRUARY 2.—"The Production of Wheat in the British Empire." By ALBERT E. HUMPHRIES, Chairman of the Home-Grown Wheat Committee. The Rt. Hon. EARL CARRINGTON, K.G., G.C.M.G., will preside.

MARCH 16.—"The Colonial Wool Trade." By S. BANKS HOLLINGS.

APRIL 6.—"Ceylon: its Industries and Material Progress." By the Hon. JOHN FERGUSON, C.M.G. The Rt. Hon. SIR WEST RIDGEWAY, G.C.B., G.C.M.G., K.C.S.I., will preside.

MAY 4.—

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

G. L. ADDENBROOKE, M.I.E.E., "The Public Supply of Electric Power in the United Kingdom." Three Lectures.

LECTURE III.—FEBRUARY 1.—The distribution of electric energy at high pressure—Electric energy at the consumers'—The development of electric power supply in the United Kingdom—Some observations on the legal position and on the relations of public and private enterprise.

LEON GASTER, A.M.I.E.E., "Methods of Artificial Illumination." Four Lectures.

February 15, 22, March 1, 8.

GEORGE GERALD STONEY, M.Inst.C.E., "Steam Turbines." Three Lectures.

March 22, 29, April 5.

F. W. LANCHESTER, "Aerial Flight." Three Lectures.

April 26, May 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 1...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. G. L. Addenbrooke, "The Public Supply of Electric Power in the United Kingdom." (Lecture III.)

Farmers' Club, Whitehall-rooms, Whitehall-place, S.W., 4 p.m. Mr. Kenneth Mackenzie, "The Management of Grass Land."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7½ p.m. Inaugural Address by the President, Mr. Edward John Silcock.

Chemical Industry (London Section), Burlington-house, W., 8 p.m. Colonel Sir Frederick Nathan, "Gunpowder and its Manufacture."

British Architects, 9, Conduit-street, W., 8 p.m. President's Address to Students.

Victoria Institute (at the HOUSE OF THE ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.), 4½ p.m. The Ven. Archdeacon W. Cunningham, "Christianity and Socialism."

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. E. A. Gardner, "Nature and Convention in Ancient Art."

TUESDAY, FEB. 2...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Colonial Section.) Mr. Albert E. Humphries, "The Production of Wheat in the British Empire."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. A. Macdonell, "The Architectural and Sculptural Antiquities of India." (Lecture I.)

Alpine Club, 23, Savile-row W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Professor Bertram Hopkinson, "Heat-Flow and Temperature-Distribution in the Gas-Engine."

WEDNESDAY, FEB. 3...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Bolton Smart, "The Problem of Unemployment."

United Service Institution, Whitehall, S.W., 3 p.m. Captain E. A. Steel, "Exploration in Southern Nigeria."

THURSDAY, FEB. 4...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Dr. F. Börgeson, "*Fucus spiralis* (Linn.)." 2. Mr. C. Morley, "Economy of Ichneumon Manifestator (Linn.)." 3. Rev. Canon Norman, "The Polyzoa of Madeira."

Chemical, Burlington-house, 8½ p.m. 1. Mr. M. O. Forster, "The Triazo Group." Part VII. "Interaction of Benzhydroximic Chloride and Sodium Azide." 2. Messrs. M. O. Forster and R. Müller, "The Triazo Group." Part VIII. "Azoimides of the Monobastic Aliphatic Acids." 3. Mr. A. W. Crossley and Miss Nora Renouf, "Nitro Derivatives of Ortho-xylene." 4. Mr. A. C. F. Egerton, "The Divergence of the Atomic Weights of the Lighter Elements from Whole Numbers." 5. Messrs. G. Martin and F. S. Kipping, "Benzyl and Ethyl Derivatives of Silicon Tetrachloride." 6. Messrs. F. B. Power and C. W. Moore, "The Constituents of the Bark of *Prudus Serotina*. Isolation of 1-Mandelonitrile Glucoside." 7. Mr. B. Flürscheim, (*a*) "The Mechanism of the Reduction of Nitroanilines and Nitrophenols." (*b*) "The Relation between the Strength of Acids and Bases and the Quantitative Distribution of Affinity in the Molecule." 8. Mr. T. S. Patterson, "A Simple Notation for Indicating the Configuration of the Sugars and Allied Substances." 9. Mr. F. E. E. Lamplough, "Note on the Determination of the Rate of Chemical Change by Measurement of the Gases Evolved." 10. Messrs. S. R. Best and J. F. Thorpe, "The Formation and Reactions of Imino Compounds." Part VIII. "The Formation of Methyl Derivatives of 1-3-diamino-2-phenylnapthalene from the Three Tolylacetonitriles." 11. Mr. T. P. Hilditch, "The Effect of Conjugated Unsaturated Groups on Optical Activity." Part I.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. W. Poel, "Shakespeare and a National Theatre."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Archer, "The Revival of Modern Drama." (Lecture I.)

Civil and Mechanical Engineers, Caxton Hall, Westminster, S.W., 8 p.m. Prof. Henry Adams, "The Stability of Arches."

FRIDAY, FEB. 5...Royal Institution, Albemarle-street, W., 9 p.m. Prof. J. C. Frazer, "The Influence of Superstition on the Growth of Institutions."

Architectural Association, 18, Tufton-street, S.W., 7½ p.m. Mr. J. H. Markham, "Reinforced Concrete."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Sir Whately Eliot, "The Design and Construction of Docks." (Vernon-Harcourt Lecture.)

SATURDAY, FEB. 6...Royal Institution, Albemarle-street, W., 3 p.m. Sir Alexander Mackenzie, "Mendelssohn."

Journal of the Royal Society of Arts.

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FRIDAY, FEBRUARY 5, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, FEBRUARY 10th, 8 p.m. (Ordinary Meeting.) ARCHIBALD R. COLQUHOUN, F.R.G.S., M.Inst.C.E., "Bosnia-Herzegovina."

Further particulars of the Society's meetings will be found at the end of this number.

EXAMINATIONS.

The Society's Examinations will commence on Monday, March 29th.

The last day for receiving applications from Local Committees is Tuesday, the 23rd February, and after that date none will be received under any circmstances whatever. Application forms from the Provinces should therefore be posted not later than Monday, the 22nd February. Committees may, however, close their entry lists at an earlier date, if found desirable.

Copies of the Programme for 1909, with full details, together with the questions for 1908, and reports by the Examiners, can be had, price 3d. (post-free 4½d.) on application to the Secretary, Sir Henry Trueman Wood, Royal Society of Arts, Adelphi, London, W.C.

The questions for the years 1900, 1902, 1903, 1905, 1906, and 1907 can also be obtained (price 4½d. each year, post free) on application as above.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1s. 6d. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURE.

On Monday evening, February 1st, Mr. G. L. ADDENBROOKE, M.I.E.E., delivered the third and last lecture of his course on "The Public Supply of Electric Power in the United Kingdom."

A vote of thanks to Mr. Addenbrooke for his course of lectures was carried unanimously on the motion of the Chairman.

The lectures will be published in the *Journal* during the summer recess.

COLONIAL SECTION.

On Tuesday afternoon, February 2nd, Mr. ALBERT E. HUMPHRIES (Chairman of the Home-Grown Wheat Committee) read a paper on "The Production of Wheat in the British Empire." The Right Hon. EARL CARRINGTON, K.G., G.C.M.G., presided.

The paper and discussion will be published in the next number of the *Journal.*

EIGHTH ORDINARY MEETING.

Wednesday, February 3, 1909; SIR STEUART COLVIN BAYLEY, K.C.S.I., C.I.E., in the chair.

The following candidates were proposed for election as members of the Society:—

Birkett, Percy, A.M.I.Mech.E., Explosives Factory, Hiratsuka, Japan.

Johnson, Robert Baines, M.A., J.P., The Hope House, Little Burstead, Essex.

Kershaw, Thomas, M.I.Mech.E., 170, Sannomiya-cho, 1 Chome, Kobe, Japan.

Pearson, Henry C., Messrs. R. and S. Garrard and Co., 25, Haymarket, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Andrew, John Ingram, M.Inst.N.A., Messrs. G. Fenwick and Co., Limited, Hong Kong, China.
Arundel, Sir Arundel Tagg, K.C.S.I., Uplands, Maybury-hill, Woking.
Benson-Nicol, Louis Hotspur, Warri, Southern Nigeria.
Bowden, Cyril, F.R.C.I., F.R.G.S., Union Club, Malta.
Brown, William Hervey, Standard-buildings, Leeds.
Cheah Cheang Lim, Ipoh, Kinta, Perak, Federated Malay States.
Deacon, Octavius, 150 and 154, Leadenhall-street, E.C.
Fortescue, Nathaniel, J.P., Hainhault, The Drive, Chingford, Essex.
Golding, Henry J., 16, Algiers-road, Ladywell, S.E.
Gupta, Karunakanta Das, B.A. (Cal.), Sibsagar, Assam, India.
Harvey, George B., 4, St. James's-street, S.W.
Headlam, Lieut. Edward James, R.I.M., care of Director of Royal Indian Marine, R.I.M. Dockyard, Bombay, India.
Henriques, Alexander Lindo, Bocas del Toro, Republic of Panama.
Jaggard, William, 139, Canning-street, Liverpool.
Khoo Cheow Teong, 24, Light-street, Penang, Straits Settlements.
Khoo Siew Jin, Kuching, Sarawak, Borneo.
La Touche, Sir James Digges, K.C.S.I., 14, Gledhow-gardens, S.W.
MacGregor, John Stewart, Briar Bank, Francis-street, Leeds.
Martin, Robert M., 34, Molesworth-street, Dublin.
Maruta, Hidemi, Mitsu Bishi Dockyard and Engine Works, Nagasaki, Japan.
Mhatre, Mungalrao Ramjee, 268, Kumbharwada-street, Girgaum, Bombay, India.
Mistry, Shapoorjee Dhunjeebhoy, Chief Engineer, The Gujarat Ginning and Manufacturing Company, Kolupur Post, Ahmedabad, India.
Peters, Major Cecil, Sunbury Manor, Middlesex.
Phillips, John, 36, Lincoln's-inn-fields, W.C., and 20, West 25th Street, New York City, U.S.A.
Reid, Edward George, Colonial Surveyor's Office, Turks Islands, British West Indies.
Roxburgh, William, 25, Portland-road, Kilmarnock, N.B.
Scott, John C. H., 32, Kensington park-road, W.
Sethna, Nowroji Sorabjee, 76, Gogha-street, Fort, Bombay, India.
Stewart, Charles William Arnott, 2, Marchmont-road, Richmond, Surrey.
Stones, William, Northwood, Seymour-grove, Old Trafford, Manchester.
Wee Hap Lang, 19, Roger-street, Kuala Lumpor, Selangor, Federated Malay States.

The paper read was—

THE PROBLEM OF UNEMPLOYMENT.

By Bolton Smart,

Superintendent of Hollesley Bay Labour Colony.

The problem of unemployment is vast and complex, its constituent elements are ethical, physical, and economic; almost imperceptibly they melt into each other, and completely to resolve either, we must recognise the whole. I cannot hope to deal adequately with so large a question, but so far as I am able I want to suggest a definite constructive policy. If we wish to arrive we must know our destination. That, then, is the minimum social aim.

I think this gathering will agree with me we can have no lower aim than to drive out the haunting spectre of hunger from the home of every honest worker. To make every willing worker in this great country secure of the necessaries of life is not utopian. It was the largely-realised standard of mediæval history. The early economists failed to discover the defects of their gospel, and built their industrial system upon two false assumptions: (1) the equality of capital and labour when settling terms, and (2) the equality of industrial units for a competitive system.

The history of the Trades' Union movement is largely the story of an attempt on the part of labour to realise what the early economists wrongly assumed.

The demand for shorter hours, standard wages, and Employers' Liability has forced the employer to adopt the natural defence of selection. This defence, reinforced by labour-saving machinery, has tended to intensify the "out-of-work" problem. I am therefore persuaded that free industry with a cash nexus and unrestricted competition must be reconsidered.

The only proposal I make here is, that the competitive system must be humanised to an extent sufficient to reach a healthy, minimum industrial security. That is, every willing worker must be saved from the terrible anxiety he now suffers in relation to the necessaries of life.

I must mention one other historic feature. At the beginning of the eighteenth century about one-sixth of the entire population was contained in the families of the yeomen of England, who owned and tilled the land. At its close they had practically disappeared. We all know the story, probably most of us feel it was economically inevitable, but I venture to suggest the reasons were social and political, rather than economic. The loss of the

land, and the loss of industrial security were, I think, evil and unnecessary by-products of the eighteenth century revolution. The nation soon became conscious of grave danger, and recognised that something must be done to restore, under modern conditions, the life of the old village community. So far back as 1832 we have the Workmen's Allotment Act, extended in 1882. The Allotment Acts of 1887 and 1890, and the successive Small Holdings Acts of 1892 and 1907 (springing from both sides of the House), point significantly to the land as a large factor in the solution of our problem.

Two things emerge from our reference to history:—(1) the necessity to adjust our industrial system to human necessities, and (2) the necessity of land reform, with a view to renewing the rural life of the country. Assuming the extreme gravity of the problem, where should reorganisation commence? There is, I am glad to say, a common agreement that, as a preliminary to dealing with the unemployed problem, we must deal with underemployment.

This evil can certainly be defined (and I believe largely obviated) by careful organisation. The casual worker cannot be organised on a voluntary basis; legislative action will be necessary. Compulsory registration on the part of the men, and compulsory employment from the register on the part of the employer would be essential features. In this way the unnecessary surplus could be determined, and passed for the time being into the ranks of the unemployed. The casual would only be casual in the sense of working for many masters, and several advantages would accrue. The common standard of life would be raised, the discipline of steady employment applied, and greater industrial security enjoyed. The way would then be clear for an effective diagnosis of the extent of unemployment. Here again organisation would play its part. Some way must be found for effecting a complete registration of all unemployed persons, with facilities for distributing labour wherever required. Possibly a good deal of this work could be done on a voluntary basis, but, where necessary, the aid of the State must be sought.

I am of opinion that the authority appointed to deal with the unemployed problem should be national, and that the machinery set up should deal with all technically able-bodied persons out of employment, from the vagrant to the highly skilled artisan. These may be roughly divided into three classes:—(1) The able and willing, (2) the unable but willing, (3) the able but unwilling.

Before offering suggestions upon schemes of help for the unemployed I want to mention some proposals aiming at a more equitable distribution of labour. If there is even the remotest chance of making room for more men in the normal ranks of labour, such proposals should at least have eager and careful consideration. I would include such questions as "overtime" and "piece-work," and the labour of married women and juveniles.

In considering juvenile labour, the whole subject of education and training should be reviewed. I am convinced that a double advantage would accrue, in the possible easement of the immediate problem of unemployment, and, more important, brightening the outlook for to-morrow.

In considering how we may best deal with men and women suffering from unemployment, it is well to remember that a legal responsibility now rests upon certain authorities to prevent any person suffering from lack of the bare necessities of life. In other words, the State assumes (through its appointed agents) responsibility for the prevention of starvation. To prevent this calamity the State has erected certain machinery in the Poor Law Reform Act of 1834. This legislation was designed to abolish certain scandalous procedure, and to fulfil fairly the legal obligations of the State towards the poor. It has been modified and amended from time to time, but in the main it has always stood for the minimum legal responsibility of the State. For fifty years after the Poor-law reform special periods of distress were met by special charitable efforts, more or less wise, but always generous.

In 1889 came the great dock strike, accompanied by the recognition of the terrible waste and damage caused by a system of unorganised casual labour. At this time, also, came the first real attempt to decasualise by a ticket system. This led to the displacement of some 7,000 men, who, with their dependents, numbered at least 20,000. This distinct and difficult problem led to a Mansion House Conference, followed by a Mansion House Fund, but not this time to be distributed in dole fashion.

A carefully devised scheme for the application of a work test, and a really earnest attempt to reinstate by emigration, migration, &c., was devised and administered. Other schemes followed in later years, always avoid-

ing the dole, and aiming at reinstatement. A body of informed administrators emerged from this work equipped with valuable knowledge and experience.

This brings us to the distressful period of 1903-4. The close of the South African campaign, synchronising with the great slump in the building trade, flooded the labour market. Poor Law Guardians in almost all urban districts were soon in distress, and the Local Government Board was approached with a view to special measures for the relief of the unemployed.

Subsequent events will be fresh in our minds. Mr. Long's circular to Guardians, with the semi-statutory machinery for dealing with the unemployed set up by him, was confirmed and extended by Mr. Gerald Balfour's Unemployed Workmen's Act of 1905.

This Act recognises the national character of the problem, and assumes State responsibility for its amelioration. It is manifestly weak, and to some extent inoperative, from the administrative standpoint. Everyone knows the futility of seeking voluntary funds for rate-aided schemes, yet this principle was adopted. It laid down a perfectly illogical distinction betwixt maintenance paid to the family, and administrative charges, the latter including expenditure for emigration and migration. The former was to be raised from voluntary sources, and the latter by a special rate. In one particular, since modified, the Act was harsh, if not positively cruel—I refer to the barring of applicants who had received parish relief—while the gravest shortcoming was that no provision was made for the continuance and extension of valuable experimental work aiming at the training and settlement of the town-bred man on the land.

Briefly recited, we have with State and municipal responsibility set up several alternative methods of treatment. Under the Poor Law we can either admit to the house, or open the labour yard under the "Labour Test Order." The municipality can, under certain circumstances, anticipate public works. Distress Committees can, under the new Act, emigrate, migrate, or give doles of work.

I have purposely left out voluntary organisations, not because I underestimate their great value from the experimental standpoint, but because I feel strongly this is a grave and perilous problem, for which the State must be held responsible.

Let us glance briefly at the State and municipal provisions. The indoor workhouse treatment for the respectable workman and his family is, apart from its enormous expense, rapidly becoming impossible for higher and nobler reasons. The "Labour Yard" has broken down for lack of suitable employment and from deep repugnance to associating the decent workman with the Poor Law.

Our experience of anticipated municipal work does not encourage hope either from the standpoint of cost or the shortage of work inevitably following the anticipated job. Emigration, migration, and doles of work, under proper conditions, are all good ingredients for amelioration. Emigration must be only for willing men, and in every case townsmen should be properly trained, and the wife and family given some experience of country life at home, before starting the prairie farm experience. Settlement in the new country must be properly organised under the eye of the Home Government. Our kinsmen across the water should be willing to pay something for our care in selection and training. Emigration should be included as part of a scheme for the scientific distribution of labour. I can see many strong reasons for including emigration and migration in one Imperial scheme, but always with the provisions stated above respecting emigration. Doles of work will always be necessary, but are effective only when they bridge the period of necessity.

It will be seen, therefore, that from my standpoint, the Act of 1905 is excellent (in the main) as far as it goes, but I suggest it should be amended and extended to cover the following requirements :—

(1) The compulsory organisation of casual labour.

We all recognise the train of wretchedness and ruin that dogs the life of the casual worker, but the unholy word "compulsion" calls for serious consideration, as it affects the employer equally with the *employé*. I can only reiterate that the organisation of casual labour is absolutely essential, and you cannot effectively organise without compulsion. If compulsion here is evil, surely it is far and away the lesser of two?

(2) The compulsory registration of all unemployed persons, with a national or imperial organisation for the scientific distribution of labour.

The Labour Exchange cannot increase work, but it can save endless difficulty and suffering as the intelligence and transport agency for the worker. A national basis pre-

sents the minimum area for effectiveness, and I see no reason why it should not embrace the Empire.

(3) The provision of employment, training, or education for all unemployed persons, with maintenance allowance during the period of unemployment, including powers and financial facilities for training and settlement on the land.

(4) The placing under detention certain persons now vagrant or persistently lazy.

The provisions of Nos. 3 and 4 practically involve the whole of the machinery for providing occupation. In considering this we should keep in mind the roughly classified types:—(*a*) The able and willing, (*b*) the unable but willing, (*c*) the able but not willing.

It will be essential to provide a variety of occupations and methods of management. We must, therefore, know in what proportion those classes exist. Until we have fuller information it is impossible to be accurate, but at the present moment I would say No. 1 (*a*) outnumbers No. 2 (*b*), but the relative proportions of (*a*) and (*b*) will always depend upon the labour market. When the good time comes class (*a*) will be affected first. Class (*b*) will only be seriously reduced as (*a*) becomes absorbed. Class (*c*) is, I think, permanently smaller than class (*b*). There can be no doubt that a large number in classes (*b*) and (*c*) have fallen from class (*a*).

With our present haphazard organisation of industry (or lack of it), the able and willing are in times of slackness broken in health and spirit, and taught to loaf by compulsion. I contend it is in the highest interests of the nation from every standpoint that this wicked waste should stop.

From the purely economic standpoint it is true the employer and *employé* suffer together in times of depression, but from the human standpoint there is generally no comparison. In the one case the last defence is down and the enemy inside, in the other it is almost always possible to call up reserves.

To preserve the workman in physical fitness and good *morale* is better business than making physical wreckage, ricketty children, paupers, and criminals. Ultimately, too, I believe it will cost less.

It is a fact that to-day you can keep together a London workman's family and home, and thoroughly train the man in horticulture or agriculture until he is fitted to start life on the land in his own or any other country at a little over one-third of the cost of breaking up his home and housing the family in a London workhouse. The Farm Colony therefore will, I think, play an important part. My experience leads me to recommend three types of colony:—

(1) A training colony for men found suitable and keen to settle on the land, at home or abroad. This colony should be associated with a well-organised scheme for grouped co-operative small holdings. In the case of married men the maximum period of separation from the family should be three months. If at the end of this period the man was found suitable and was keen for life on the land, he should be joined by his family, and occupy a cottage during the remaining period of his training; after which he should be passed into a grouped association of small holdings, or, if he wished, proceed to the colonies.

(2) Should be designed for men who, without being criminal, vicious, or persistently lazy, are suffering from defect of character or physique. The hope of passing to No. 1 Colony should be set before them, and other means used for stimulating a healthy desire for work and betterment. The open air life and regular feeding will be the best remedies for restoring physique.

(3) Would be for men who have made up their minds never to work again. It would be essential to have powers of retention, and the dietry would be in proportion to industry, but in and through all there must be flowing human feeling and hope of better things.

From colonies Nos. 2 and 3 there will probably be a residue that we must consider a permanent burden, but these would eventually cover (by their own labour on the land) a good portion of their cost for maintenance.

That town-bred men can be trained for horticultural and agricultural work has been proved by experience at Hollesley, where to-day London men may be seen engaged in every kind of garden and farm work, including nursery and forest work, and in the evening attending technical classes for horticultural and agricultural subjects. Whether or no the town-bred man will be successful as a small holder remains to be proved. I can only say I am more hopeful of success to-day than I was at the commencement of the colony four years ago. Unfortunately, as I have already pointed out, the Act of 1905 made no provision for this important experiment, and we have, with what patience we could muster, "marked time," and gained valuable experience. The issues of this experiment are so important that,

whether we finally succeed or fail, it will be good national business to settle once for all whether it is practicable or not.

As a first step, I should like to see experimental farm colonies and associated holdings set up under the varying conditions of different parts of the country. Ultimately these training colonies and associated holdings could be incorporated as part of a national scheme for training in agriculture, horticulture, and afforestation.

The second occupation of importance for the unemployed would be afforestation. The recent report of the Royal Commission warrants a large hope, and makes it unnecessary for me to pursue the matter further.

Recovery and protection of foreshores, national roads, or any other work issuing in national assets, will all be available as necessity presses and wisdom directs. Some think that even then there will be a surplus of workers still unemployed. For these training and educational provision must be made, so that no single worker falling out of the ranks of labour shall be allowed, either through misfortune or choice, to start on the way that leads to moral and physical ruin. There are many things that are left unsaid for lack of space and time. Land reform, housing, facilities for drinking, might each occupy my whole space, and are vital elements of our problem. The education and training of the young, the labour of women and juveniles, a statutory day, overtime, piecework, and so on, have been only mentioned, but they all demand the most careful consideration.

In conclusion, I would urge that this most terrible problem, throbbing with the cries and sufferings of our brothers and sisters, must not be allowed to become a party question. Also, I would urge it is more, much more, than a purely economic question. It presents a field of service demanding the united efforts of the nation, and only in the measure of our national consecration to this high service are we justified in expecting adequate amelioration of its dire results and the gradnal effacement of every curable cause.

DISCUSSION.

The CHAIRMAN, in opening the discussion, thought the audience would be agreed that the author had given an exceedingly interesting paper, which dealt seriously with the most insistent of all problems which the people of this country had to face; and if his remedies were, in the opinion of many, somewhat heroic, they would all admit that the insistence of the problem in its dark significance quite justified him in putting forward any remedy that he thought sufficiently strong to grapple with it. He (the Chairman) was specially interested in the Hollesley Bay work rather than in the general problem for the reason that he had seen how, under the author's superintendence, and thanks to his sympathy, industry, and capacity, the London unemployed man became raised in character, and capable of taking his place whether as a colonist, market gardener, or farm labourer. That was a practical way of dealing with at all events the fringe of the problem. The other portion of the question, what might be called the political or platform remedies, whether they be built, as the author's were, round the right to work and the State organisation and employment of labour, or whether they were taken from the opposite point of view and built round questions like Tariff Reform, in either case they dealt with a state of things that did not exist at present. What had to be faced at the present moment was the stern significance of the unemployed labour of to-day and not of to-morrow. If it was correct to suppose that the Hollesley Bay experiment had been a real success —and he fully believed it had—he saw no reason why the experiment should not be multiplied and extended all over England, and why it should not deal for the moment with a very large corner of the unemployed question. But there were a few points about the Hollesley Bay experiment on which he would be glad of further information. In June, 1907, a report was published by the County Council giving particulars of the colony when it was in an experimental stage, but it had since been enlarged, and he thought it was almost time the central body gave a little more information about it. First of all, it would be most useful if the author could state what was the cost of training a labourer in the colony, and what became of those who went through the colony. What became of those who were not found fit for employment on the land as colonists, market gardeners, or labourers? Did they find other employment, or did they go back to enlarge the general body of the unemployed? He thought all were agreed that a Central Labour Office for the purpose of co-ordinating all the information to be obtained from both sides with regard to the wants and requirements of labour was desirable, and that it should be taken up by the State and not by the municipality. He did not know what the author meant by the organisation of casual labour. Unless the casual labourer was put upon the register together with the unemployed labourer, he did not understand the author's suggestion. He further suggested for Mr. Smart's consideration whether the registration of labour would not require to be something more than the registration of unemployed labour. The unemployed of to-day was the employed of to-morrow, and the employed of to-day was the unemployed of to-

morrow: would it not, therefore, be necessary to make a complete register of employers, employed and unemployed? But at the back of all remained the fact that the whole scheme depended upon the English people being brought, within a reasonable space of time, to accept a state of affairs in which all the relations of labour between employers and employed would be State regulated. It was quite certain, however, that that could not take place at present, and even if legislation to that effect were introduced to-morrow it could not usefully be carried out in a practical manner within the lifetime of many of the present unemployed. It was a question for the future, and he wanted to know what solution could be offered for the difficulties of the present. Behind all the other difficulties, the question naturally arose, would the scheme produce more work; if so what would it cost, and where would the money be found?

Mr. H. Luttman-Johnson, as a Guardian of the Poor and a member of the Westminster Distress Committee, thought it was not necessary to consider the various theories which had been promulgated as to how the world was to be regenerated in a more or less short time. He thought a great deal might be done towards solving the problem under consideration by means of special arrangements, such as the colony at Hollesley Bay and others which had been established on the continent, which had proved more or less successful, without coming to any conclusion as to the main points by which society was to be regenerated. There was no doubt that Hollesley Bay had been a great success, the men who had been sent there having shown an aptitude for the work which could hardly be expected, particularly as they had not been in any way selected. There had been no attempt to pick out those men who could be expected specially to profit from the teaching. But Hollesley Bay was started with the view of educating townsmen and then settling them on the land. Up to June, 1907, the date of the last Report, none had been settled on the land, and it would be interesting to know whether any had been settled since, and whether they had remained there, because it was no good sending men on to the land if they afterwards went back again to the towns. The success of the experiment must be judged by the results.

Mr. D. F. Schloss said he presumed he had been asked to speak because it had been his duty on several occasions to visit foreign labour colonies. There was, however, nothing whatever in any of those colonies that corresponded to the experiment at Hollesley Bay, and he was afraid, therefore, he could not add usefully to the discussion. The author had divided the unemployed into three classes, those who had gone to Hollesley belonging to the first class. The labour colonies on the continent were not intended for, nor were they filled, by such people. If a discussion took place on what should be done with the other classes, the unable but willing or the people who were able but not willing to work, then a great deal of the continental experience might be useful.

Miss M. Hicks, speaking as a member of a Distress Committee, said she knew a great many of the men who had been sent to Hollesley had gained in health and learned much while they were there, but at the end of their term they had been returned on to the streets of London again. The great failure of the system was that there was no permanency in the work. Another great drawback was that, even supposing the men were willing to follow an agricultural occupation, no provision was made for the training of their wives; and she knew that many of the wives of the men were not willing to go into a country place where they knew nothing about anything. It was absolutely necessary, unless the wives were to be a dead weight on the men in the future, that they should have some amount of training too. She was greatly disappointed that the author had not referred to the question of the causes of unemployment, because no permanent benefit would result until that question was dealt with. From a local canvass from house to house she discovered that the majority of those unemployed in London were skilled workers, although she was well aware of the fact that five-sixths of those who applied to the distress committees were unskilled labourers. That was simply due to the fact that the skilled labourers did not apply because they knew there was nothing for them. The only possible remedy for that state of affairs was a compulsory registration of all those who were out of work and their trades, and some clue would then be obtained to the reason for unemployment, which was no doubt to a large extent due to the disorganisation of trade. As far as she could ascertain, casual labour was enormously on the increase, even in the most skilled trades, such as electrical engineering, owing to the fact that so much piece-work was done. If, therefore, a large proportion of the unemployed was skilled labour, the training of the workers did not solve the problem. She had been a superintendent of the women's work movement in St. Pancras, in connection with which large numbers of skilled workers were instructed who, however, were often thrown on the unemployed market. It was absolutely necessary to find permanent work in order to obtain any remedy for the present evil.

Mr. J. P. Wallis, speaking from two years' association with the Hollesley Bay work and the Unemployed Body, said he knew from experience that some of the finest material in the world in the shape of human beings was at Hollesley Bay, consisting of men who had fallen out of work through slackness of trade and other circumstances. Some of the men were in such a starving condition at first that they were not fit to work and totally unemployable, but after four months at the colony they had been

brought back to manhood and self-respect again. Of course, some of the men who went there did not do as well as others, some simply desiring to get a few months' change of air, but such men were sent back if possible before their time was up, and more often they went back of their own accord. Fresh air and enforced cleanliness did not suit some people, but there were not 5 per cent. failures at Hollesley. The wives and families of some of the men had also been down to the colonies, and he was sorry to say that some of the men would never really be men with the wives they had got, although he was thankful to say that was true only of a few instances. A few months ago forty-five men were sent out from Hollesley Bay to settle in various parts of England, and only one of them had turned out a total failure. He thought most people in ordinary life would be very pleased with the result if they only had one failure out of forty amongst their servants and workpeople. The work had to be judged, not according to a high standard and ideal, because men suffering privations had to be taken and built up again into men, some of them being a fortnight, three weeks, or a month at the colony before they were able to do a day's work. The question to be borne in mind was whether it would cost the community more to keep such people under the present Poor-law conditions than it would to train them to use their muscles and brains, and make them self-respecting and supporting. They desired to remove the canker of poverty and unemployment which was in their midst; and, speaking as a business man, who had joined the Central Body from the borough he represented, and who went into the work as a countryman, rather prejudiced against the scheme, he wished to say that he thanked God the Legislature and people generally were alive to the necessity of building up fallen men.

Mr. JOHN J. LEWIS said it was an open secret that Hollesley Bay had been a success so far as the training of the men on the land went, but he desired to ask how many of those who passed through the colony remained on the land. As the author was dealing with training on the land, he would like to hear him refer to the land laws of the country, because he maintained that everything upon which the community lived came out of the earth, and therefore on the earth man must live. He thought it would be far better if they dealt with the man that was coming out of the country into the town, and in that way got rid of the superfluous labour in the towns which ought to be in the country. He would be greatly indebted to Mr. Smart if, in his reply, he would say what his ideas were with reference to any alteration of the land laws.

"Colonel" DAVID LAMB (Salvation Army) said he could speak with some experience of the subject under discussion, having been the resident Governor of the Hadley colony for some years, and during recent years the Director of the Emigration work of the Department. Speaking for himself, and not for the organisation of which he was a member, he thought classes B and C ought to be tackled first. The presence of the unemployable and the man who would not work in the ranks of the unemployed, confused the serious consideration of the question at every turn. He would take steps to remove such men at once. He would permanently segregate those who were, humanly speaking, irreclaimable, and take steps so that the propagation of the species was stopped. That would clear the ground for dealing with class A. He had sympathies with the small holdings movement in England, but he was doubtful if it was possible to colonise England while it was a free trade country. The Empire should be colonised by all means, but he doubted if it was possible to colonise England. He was very glad to hear the author's tribute to the general industry and adaptability of the Londoner. While he did not advocate any dumping down of the Londoner out on the prairie, he thought the author would be well-advised if he did not insist so strongly on training at home, because he would find that a good deal of it would have to be unlearned when the colonist arrived in Australia, South Africa, or Canada. He recently asked a man who had been out in Canada for the last 26 years the type of man he preferred for agricultural work in Canada, and he replied, "Give me a Scotchman first, but after that give me a Londoner, and the man who has no knowledge of agriculture." He thought it would be a long time before any grants would be obtained from the Colonies in the way the author had suggested, although they might start some training-homes where people who had been selected for emigration would be received. He was sorry the author did not touch on the question of seasonal unemployment. If there was a severe winter in this country, as in Canada, provision would be made for it, but as it was, the people of this country muddled through.

Mr. H. LEONARD HUMPHREYS criticised the Chairman's statement that it was not necessary to consider theories as to causes and possible remedies of how best to treat the problem as it presented itself to-day. Those who dealt with the problem day by day recognised that the existing condition of things was the result of neglecting to deal with the causes that had produced those conditions. For many years past they had muddled along in dealing with the problem as it occurred year by year, as, for instance, in West Ham, but a solution would not be arrived at until the root of the question was dealt with, and an effort was made to discover what were the causes and how they should be remedied. The whole problem resolved itself into the query how best to restore to increasing masses of the workmen of England the industrial independence they had lost. It was necessary to recognise that the personal causes of the trouble, such as loafing and

drunkenness, were in a large part the results of unemployment itself. It was no use saying drink was the cause of unemployment; it was both a cause and an effect, just as poverty itself was a cause and an effect. In studying the industrial and economic bases of the problem, the need for the organisation of casual labour would be seen; and that could only be brought about by getting employers to aid in the registration of casual labour in each populous centre, so that they might draw upon the register for the few days of labour they required. The question of restoring to a man his industrial independence seemed in many respects impossible, from the fact that one of the causes of the present-day problem was the ever-changing features of industries. Owing to the general advance of machinery many artisans had lost the trade at which they were once able to earn their living, and in that way he saw a greater hope for the agricultural labourer. He could confirm from his experience in West Ham the excellent results which had been obtained on labour colonies. The simple reason the men had not remained on the land was that a man with only 16 weeks' training was not turned into an agricultural labourer, and would not be employed by a market gardener or farmer. Scope was needed for a longer training of at least one year, and not a single season.

Mr. J. R. Brough thought that, although the conscience and interest of the nation was aroused in the problem, it would be many years before the conditions of labour could be so altered that the country was not faced with unemployment. In the present highly organised form of business there must be slumps and booms in trade, and the question arose whether the State should not be prepared to step in when trade was "slumpy," and make economic use of the surplus labour. The State was beginning to recognise that, and he hoped in the Bill that would be brought before the House of Commons this year, it would be found that the Government was attempting, by vast national schemes of afforestation, or dealing with coast erosion, to take up the surplus labour at certain times and make use of it, and bring it back when it was required to be worked economically in the market. For some years a steady advance had been made. A few years ago people were content with a Mansion House Fund, and the Hollesley Bay experiment had been more or less tentative. They had been learning by experiment how best to proceed. The scheme would have been far more complete if it had been found that the Act enabled them to apportion pieces of land to a certain number of men who had received training, and thus put to practical proof the question whether a man could support himself on a small piece of land after he had received that training. At least 100 cottages and small holdings would be required for that purpose, because to be successful there must be a co-operative society among the men to enable them to provide the things they required. Unless it were possible to bring back a great deal of surplus labour to the land, one of the most important parts of the problem would have been overlooked. Having served on the Central Unemployed Body, and having visited Hollesley Bay on several occasions, he could bear testimony to the usefulness of the place as a sound experiment. If they had not emigrated and migrated men from Hollesley, but had simply given them sixteen weeks in the fresh air, inculculated in them habits of order and discipline, and set them up in health, and brought them back better able to fight the battle of life, it would have been good work. Even with only sixteen weeks training, it was possible to give a man a very good idea of the rough farming required in Canada, where they were much more ready to take a man who had that short training than a man with fixed notions. So far as he could ascertain, the view Mr. Lamb had stated was not the view of the Government, which was not interested in emigration so far as it took men out of the towns, but was desirous of getting men of the right class to go upon the land in the Far West. The Canadian Government did not look upon the unemployed Londoner as a suitable man for that work, and considerable difficulty was experienced in showing them that London men could be made suitable. Hollesley Bay had been of great advantage in that way by showing that a short preliminary training fitted the men for rough farming in the Far West. In considering the problem it was necessary to bear two things in mind. The first was that capital was being sunk at Hollesley, and that if thousands of fruit trees were planted, the capital sunk in the undertaking would not be productive for three or four years. The second was that the general cost of the scheme must be compared with the present administration of the Poor-law.

Mr. Bolton Smart, in reply, said that Mr. Brough had just mentioned the true comparison of cost. It was not fair to ask a man to solve or to ameliorate an acute unemployed problem on the same terms that he would conduct a normal commercial enterprise; it must be compared with the only possible alternative now provided for dealing with the problem. The most recent information published by the Local Government Board gave the cost of each indoor occupant under the Poor-law system for London as 15s. per week. The average family represented by the men at Hollesley was six, which would bring the cost under the Poor-law to £4 10s. per week per family; whereas the latest return from Hollesley gave the cost as 31s. 10d. per family of six, just a little over one-third of the cost under the Poor-law. Not more than five per cent. of the men had been discharged for fault. It was a very great grief to him to know that the time-expired men came back to the town, but he was not responsible for that. In the remarks he made with regard to the organisation of casual labour, he meant to imply that first of all casual labour must be defined. A casual labourer might be defined as any man who had not more than

four weeks consecutive work before him. Such a man should be compelled by legislation to register as a casual labourer in his own district, and if an employer in that district wished to employ a man for less that than four weeks, he should be compelled to get that labour from the register, of course choosing his man. If that were done, within a short period it would be known in any given district how much surplus of casual labour there was, and, instead of spreading the money which might be sufficient for a proper standard of life for 7,000 men and their families, over 10,000 men and their families, and so dragging the whole of them down, the 7,000 would get the work and 3,000 would be added to the unemployed. He intended that the registration of unemployed men should only be part of a great scheme of labour registration, which would necessarily cover the question as to the labour available and the means of getting it—in fact, an intelligence and transfer department. The whole thing would have to be co-ordinated. Of course, that would not produce more work, but all the questions that had been asked in relation to the land pointed definitely to more work. Personally, he looked upon land reform as lying at the very root of the whole question. The Chairman had asked what cost was involved in the question, and where the money was to come from. It must be clearly understood that Hollesley was only a training colony, and therefore the cost incurred in that instance was different from the cost involved in a workhouse, which was all dead capital. In a workhouse system nothing was obtained which was wanted; in fact, everything was obtained which was not required. With a labour training colony, as distinct from the reformative type of colony, the men should be constantly flowing through and settling on the land. The fact that they had not done so from Hollesley Bay was not their fault; they were greatly grieved over it, but they had marked time with as much patience as they could assume, and had been learning very valuable lessons. The number of those who had to settle on the land was—as Mr. Wallis stated—forty-three, two of whom had been incorporated in a private scheme for small holders, in which a number of men were associated together. He had been informed by the manager of that particular group of small holdings, that those two London men, trained at Hollesley Bay, who were sent to the colony under the assurance that the capital would be found them, had turned out to be two of the best men in the group. He was perfectly alive to the question of the training of women, to which Miss Hicks referred, one of the conditions he laid down being that after three months the man should be joined by his wife and family, which, of course, meant that the woman would receive training at the colony. Owing to want of time he had not referred much to the question of causes. He quite agreed with Miss Hicks that casual labour was on the increase. Colonel Lamb doubted whether it was possible to colonise England. Personally he had never said that could be done, but there was enough evidence to warrant a very careful experiment. A large body of opinion was in favour of such a scheme, and the only way to settle the point was to try it. After four years' experience of London men on the land, he was more hopeful than when he commenced the work. Mr. Lamb also mentioned the uselessness of training men in this country for work in Canada. He entirely agreed, if the men were being given three or four years' training and being made into agricultural labourers; but, as a matter of fact, if a London man who had never put his hand to a plough, or handled a horse, or milked a cow went to Canada he would receive during the first year of his employment at least 40 or 50 dollars less than a man who could milk a cow, manage a horse, and hold a plough. The great difficulty the Canadian farmer experienced was with the English agricultural labourer, who did a thing in one way and would not do it in any other. It was very important also to give a man an insight into country life, and above everything else to accustom him to the quiet and retirement of country life. Seasonal employment was a problem which would have to be faced as it had been faced in other parts of the world. A man who had a seasonal trade must learn a supplementary trade, and be able to turn his hand to other work. Mr. Brough touched upon the question of the responsibility of the State towards the reserve labour. One of the things this country ought to reproach itself with was that, knowing the necessities of a reserve of labour at times when trade was booming, she had not made adequate provision for the reserve forces in the ranks of industry, and the whole of the responsibility, pain, and suffering had fallen upon the men themselves.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Mr. Smart for his interesting paper, and the meeting terminated.

HOME INDUSTRIES.

Cotton Supplies.—In his speech, at the dinner in honour of Mr. C. W. Macara, which took place at Manchester last Friday, Mr. J. A. Hutton said that the British Cotton Growing Association "had proved that the British Empire was quite capable of supplying all the cotton, of every quality, that Lancashire requires." There can be no doubt that the Empire is capable of doing much more than this, of supplying the requirements not only of Lancashire, but of the world, if the area of cotton-growing lands is alone considered. But if Mr. Hutton means that in course of time the British Empire will not require to look outside its own frontiers for any of the raw cotton it will require, it is to be feared that, if ever it arrives, that day is still very distant. Our imports of cotton from Greater Britain increase, but very

slowly, and many years must pass before the present commanding position of the United States of America as suppliers of the cotton requirements of the world is seriously affected. Germany is not less alive than Manchester to the peril of the present dependence upon America, but although the German Government does more than our own to encourage cotton cultivation, the amount of cotton put on the German market by the German colonies is very small, and Germany itself only derives about one-thousandth part of its supplies from that source. In the season of 1905-6 the entire crop of the German colonies was about 500 tons, with a value of £30,000. The average prices were 7½d. for West African cotton, 10d. for East African, and 1s. 1d. for Victoria Lake.

Cotton Spindles and Weaving Rates.—Mr. William Tattersall writes to correct statements that have recently been made at large meetings relating to the number of new cotton spindles in this country. At the Manchester Chamber of Commerce banquet a few days ago, it was stated that 8,000,000 spindles had been put down within the last three years. Mr. Tattersall says that, as a matter of fact, the figure is, in round numbers, 11,000,000. It has been stated again that there are about 5,000,000 more spindles to be started. According to Mr. Tattersall's table, the number of spindles in mills at present being erected is close upon 3,000,000 only. It is surprising that more rapid progress is not being made with the equalisation of wage rates. Take, for example, towns as close together as Huddersfield and Halifax. The difference between weaving rates is from 20 to 30 per cent., yet Halifax weavers do not seem inclined to move to Huddersfield in search of the higher pay, and there has been as little disposition on the part of Huddersfield firms to remove their looms to Halifax, although the cost of weaving forms an appreciable proportion of the total cost of 100·120 pick worsted goods. It is now reported that a firm in the Huddersfield area is about to transfer the whole of its looms to premises in Halifax, which have been occupied in part by the same manufacturers for some time. It is said that the transfer means the saving of 10s. per loom per week. It will be interesting to note whether this transfer will lead to others, and so further the desired equalisation of wage rates; but mills and mill workers are very immobile.

The State and Fire Insurance.—It is understood that the President of the Board of Trade is considering the desirability of submitting proposals to Parliament which would make it imperative upon fire insurance companies to deposit £20,000 with the State before commencing business. Life assurance companies have long been under this statutory obligation, and the case for including fire companies would seem to be complete. The absence of the obligation in their case has given rise to a multiplication of small companies, which are tempted to accept risks they could not meet. It may be hoped that the Government will not limit its action to fire companies but will devise some means to check and crush the many concerns insuring sickness, accidents, endowment, and other insurance policies which are started without capital, and last only as long as they can collect premiums without meeting any serious calls upon them.

Wire Healds.—One of the advantages attending the use of wire healds is the diminution of the fire risk. The storage of large quantities of the highly inflammable materials of which the older types of healds were made may have been at least a contributing cause of some of the large fires which have occurred in cotton weaving factories. Manufacturers have not been very quick to change from the older type of cotton heald partly, no doubt, owing to the much greater initial cost of wire healds (about five times as much), but the cost of maintenance of the wire heald is said to be less. Wire healds at Rishton are said to have run for five years without showing appreciable signs of wear, and as they give way individual wires are readily replaced on the staves. To alter the setting from fine to coarse, and *vice versâ*, is comparatively easy, which makes it unnecessary to carry large stocks of healds. The use of wire healds is said to be making headway in weaving factories in Lancashire, and for certain classes of goods they are said to be found satisfactory.

Reinforced Concrete.—There seems to be a somewhat widely-held belief that this form of construction is too new and untried to warrant prudent business men in encouraging its use, but over fifty years ago there was an exhibit of reinforced concrete at the Paris Exhibition of 1855; in 1861 a naval engineer proposed several methods of applying it; and in 1867 M. Monier patented his system and applied it to building construction. Thirty years ago reinforced concrete constructions were being carried out on a considerable scale, and since then there has been rapid and continuous advance in its use. On one system alone it is said that over 16,000 structures have been carried out: and another system has been applied to nearly 3,000 buildings of an aggregate value of £10,000,000 sterling. It was not until 1898 that reinforced concrete was used, in any quantities, in this country, a backwardness largely attributable to the inelastic nature of our building bye-laws, but since then it has been largely used, more especially on Government buildings. Thus the new General Post Office buildings now being completed in London, and having a bulk of over eight million cubic feet and fifteen acres of flooring, the new South-Western Post Office, and the new Central Telegraph Stores at Birmingham are on three different systems of reinforced concrete. In October, 1905, the "Joint Committee on Reinforced Concrete" was formed by the co-operation of the Royal Institute of British

Architects, His Majesty's Admiralty and War Offices, the Institute of Builders, the District Surveyors' Association, and the Association of Municipal and County Engineers, for the purpose of drawing up "rules for the guidance of architects for the use of reinforced concrete," and the report of this Committee, issued in May, 1907, is a mine of trustworthy information on the subject.

The Wheat Trade.—The latest statistics of the world's wheat exports afford further illustration of the irregularity of the sources of supply upon which the United Kingdom depends for the wheat it cannot, or, at any rate, does not itself produce. For many years our imports came mostly from the United States of America, but whilst in 1901 they exported 33,000,000 quarters, in 1904 the American exports fell to 8,050,000 quarters, and though since then there has been considerable recovery, and last year the United States again stood at the head of exporting States with 18,830,000 quarters, Argentina, which in 1902 exported only 3,250,000 quarters, last year sent away 17,500,000 quarters. Next to the United States the United Kingdom used to look to Russia for supplies, but whereas, in 1902, Russia exported 14,500,000 quarters, last year her exports fell to 6,750,000 quarters. And so with India, the exports show great irregularity. In 1904 they amounted to 9,150,000 quarters; last year they fell to 575,000 quarters. It is satisfactory to be able to note the growth of Canadian exports of wheat, which in 1902 were 3,500,000 only, but last year rose to 6,500,000 qnarters. Of course, in Canada, as in the United States, the rapid growth of population increases in proportionate degree the home demand, and so affects the volume of exports. Thus, while in 1908 the wheat crop of the United States was 83,000,000 quarters, as against 79,000,000 in 1907, the exports of wheat from the United States last year were only 18,830,000 quarters, as against 19,800,000 in 1907. We are relying more and more upon Argentina for our wheat supplies, those from Australasia being very disappointing. Last year the Australasian exports were only 2,275,000 quarters, as against 4,305,000 quarters in 1907. The world's total production of wheat was highest in 1906, when it amounted to 431,655,000 quarters. Last year it fell to 408,595,000 quarters. The wheat crop of the United Kingdom, which in 1906 recovered to 7,580,000 quarters, last year was only 6,750,000 quarters. It is not only in the United Kingdom that the people are becoming more and more dependent upon foreign supplies of wheat. There is also growth in the German imports of wheat; but, whereas in the United Kingdom there is almost continuous contraction in the area under wheat, in Germany the average production of wheat during the seven years 1900 to 1906 was 25,239,949 metric tons, against 24,051,454 tons during the preceding seven years, 1893 to 1899, showing an increase of 169,785 tons per annum.

GENERAL NOTES.

Munich International Art Exhibition.—The tenth International Art Exhibition at Munich, which will be opened on June 1st and closed at the end of October, will contain exhibits from nearly all the countries of Europe and from the United States of America. Paintings, sculptures, architectural drawings, engravings, and works of art-industry will be exhibited, the last-named class, however, being admissible only on personal invitation from the Central Committee. All entries must be made by the dates specified in the various declaration schedules, particulars of which may be obtained at the Exhibitions Branch of the Board of Trade, 32, Great George-street, Westminster, S.W.

The Nancy Exhibition.—An exhibition of the art, industry, and commerce of Eastern France is to be held at Nancy from May to November this year. It has been organised under the auspices of the French Government, and through the active co-operation of the municipality and the Chamber of Commerce of Nancy. Primarily conceived as demonstrating the various activities of the 12 departments which make up Eastern France since 1870, the exhibition will also include a colonial pavilion, under the official cognisance of the Minister of the Colonies, and international exhibits. A remarkable feature will be an annexe devoted to aerial navigation. The various palaces, which are constructed of iron, are now ready to receive their respective exhibits. They stand in the Parc Saint Marie, an enclosure of some 40 acres, in the heart of the new quarter of the town.

Bank as Executor and Trustee.—At an Extraordinary General Meeting of the London and County Bank held last week, a resolution was brought before the shareholders authorising the bank to accept the office of executor and trustee and generally to transact what is ordinarily knoown as trustee business. The Chairman explained fully the advantages which would accrue to their customers, and also to the bank, by their institution being placed in a position to undertake this work; and the necessary resolution amending the memorandum of association was unanimously agreed to.

Swiss Trade with England. — For several years past Mr. Vice-Consul Milligan has been directing attention to the disparity between the amount of Switzerland's exports to the United Kingdom and her imports from this country, a disparity that, in the Vice-Consul's opinion, might be much lessened if British traders went the right way to work. But in his latest report (No. 4177, Annual Series) the Vice-Consul is able to show considerable improvement in the total value of imports from Great Britain. The total value of manufactures imported from all countries into Switzerland in 1907 amounted to £22,334,700 of which the United Kingdom supplied to the valu

of £3,258,300, as compared with £2,552,000 in 1906, or an increase of £706,300. The value of the imports from the United Kingdom—and this applies to the total imports—in 1907 was the highest on record, but the increase, so far as the United Kingdom is concerned, was largely due to the increase in the imports of cotton goods, which also account for 68 per cent. of it. If cotton imports are deducted, the result of British exports in all other branches of industry are reduced to 5 per cent. of the the total Swiss purchases of other finished goods. In the opinion of Vice-Consul Milligan, much more might be done by British traders in supplying Swiss requirements in various classes of goods, and particularly in woollen carpets, woollen, linen, and cotton ready-made goods, cutlery, porcelain, and china, finished leather goods, and gold and silver ware. Both by the Swiss Press, and by Swiss merchants, the desire is expressed to see a larger share of Swiss goods placed with British merchants in return for the large trade they do with the United Kingdom. In 1907 Great Britain took 21·8 per cent. of the Swiss exports.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock :—

FEBRUARY 10. — "Bosnia - Herzegovina." By ARCHIBALD R. COLQUHOUN, F.R.G.S., M.Inst.C.E. COL. SIR COLIN CAMPBELL SCOTT-MONCRIEFF, K.C.S.I., K.C.M.G., will preside.

FEBRUARY 17.—"The Commercial Relations of France and Great Britain." By MONSIEUR YVES GUYOT. SIR ROBERT GIFFEN, K.C.B., F.R.S., LL.D., will preside.

FEBRUARY 24.—"Hand-made Papers of Different Periods." By CLAYTON BEADLE and HENRY P. STEVENS, M.A., Ph.D., F.I.C.

Dates to be hereafter announced :—

"Railway Development in China." By ARTHUR JOHN BARRY, M.Inst.C.E.

"The Application ot the Microscope to the Study of Metals." By WALTER ROSENHAIN.

"The Resources of Peru." By C. REGINALD ENOCK, F.R.G.S.

"Afforestation and Timber Planting in Great Britain and Ireland." By J NISBET.

"The Musical Aspect of Drums." By GABRIEL G. CLEATHER. [The paper will be fully illustrated.]

"The Foundations of Stained Glass Work." By NOEL HEATON, B.Sc., F.C.S.

"The Manufacture of Nitrate of Lime." By SAM EYDE.

"The Teaching of Design." By E. COOKE.

"Furniture Design and Construction—Ancient and Modern." By PERCY A. WELLS.

"Dewponds." By GEORGE HUBBARD, F.S.A., F.R.I.B.A.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

FEBRUARY 25.—"The Buddhist and Hindu Architecture of India." By ARTHUR ANTHONY MACDONELL, M.A., Ph.D., F.B.A., Boden Professor of Sanskrit, University of Oxford.

APRIL 29.—"The Problem of Indian Labour Supply." By SELWYN HOWE FREMANTLE, I.C.S.

MAY 27.—"The Function of Schools of Art in India." By CECIL L. BURNS, Principal of the Bombay School of Art.

Date to be hereafter announced :—

"Some Phases of Hinduism." By KRISHNA GOBINDA GUPTA (Member of the Council of India).

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock :—

MARCH 16.—"The Colonial Wool Trade." By S. BANKS HOLLINGS.

APRIL 6.—"Ceylon : its Industries and Material Progress." By the Hon. JOHN FERGUSON, C.M.G. The Rt. Hon. SIR WEST RIDGEWAY, G.C.B., G.C.M.G., K.C.S.I., will preside.

MAY 4.—

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

LEON GASTER, A.M.I.E.E. (Editor of the "Illuminating Engineer"), "Modern Methods of Illumination."

LECTURE I.—FEBRUARY 15.—*Electric Lighting.* —Introduction — Incandescent electric lamps (historical summary)—Recent developments of Nernst, graphitised, tantalum, osmium, tungsten, helion, mercury carbon, and other lamps—The use of transformers—Effect on the lighting industry (Central stations, manufacturers, and consumers)—National Lamp Association and standard specifications—Lines of future development. *Arc lamps.*—The carbon arc —Open and enclosed arc lamps—Miniature arc lamps —Flame arc lamps—Open and enclosed with inclined and perpendicular carbons—Arc lamps for photographic and medical purposes — Applications and lines of future progress. Use of luminescent vapour and gases—Early mercury lamps—Cooper - Hewitt, Bastian, Vogel, Quartz-tube, Kuch, and Uviol lamps —The Moore system of luminescent gases and its applications.

LECTURE II.—FEBRUARY 22.—*Gas Lighting* —Summary of early development of gas lighting—Flat-flame, regenerative, and enriched gas-burners—The incandescent gas mantle — Its theory and action — Soft mantles and other new develop-

ments—The Hella bushlight. *High-pressure gas lighting.*—Relative merits of compressed air, compressed gas, and mixture of air and gas—Self-intensifying lamps—Automatic lighting and extinguishing at a distance—Self-lighting mantles—Liquid gas—Modern problems in gas lighting — Recent developments in street lighting in London and Berlin—Candle-power standards versus calorific power of gas; lines of further researches, Livesey professorship at Leeds.

LECTURE III.—MARCH 1.—*Lighting by Candles, Oil, Acetylene, Petrol, Air-Gas, Alcohol, and other Illuminants.*—The candle and other early systems—The petroleum lamp, its merits and drawbacks—The petrolite lamp—High pressure systems of Kitson, &c.—Modern petrol air-gas systems and their merits—Lighting by alcohol and other liquid fuels—Acetylene, its early development and difficulties—Modern types of burners — Applications to incandescent mantles — Liquid acetylene — Summary of position of modern illuminants — Comparisons of quality for lighting and radiant efficiency—Researches for further improvements.

LECTURE IV.—MARCH 8.—*General Problems in Illumination and Illumination Measurements.* — Daylight illumination and its variation — Intrinsic brilliancy of the different artificial illuminants—Effect on the eye — Methods of shading —Spectra of various illuminants—Physiological effects of light of different colours — The use of euphosglass — Modern methods of measuring light and illumination —International action regarding standards and units of light—Illumination and hygiene — The work of the Illuminating Engineering Society—The need of the illuminating engineer expert: description of his function—Concluding remarks and recommendations.

Each lecture will be fully illustrated by working specimens of the lamps and apparatus described.

GEORGE GERALD STONEY, M.Inst.C.E., "Steam Turbines." Three Lectures.

March 22, 29, April 5.

F. W. LANCHESTER, "Aerial Flight." Three Lectures.

April 26, May 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 8...Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. G. R. M. Hewson, "The Irish Land Bill."

Sociological (At the HOUSE OF THE ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.), 8 p.m. Mr. G. L. Gomme, "The Future of London."

Geographical, Queen's Hall, W., 8½ p.m. Dr. Sven Hedin, "My Recent Expedition in Tibet."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. L. E. Hill, "The Use of Oxygen for Life Saving in Mines, Submarines, &c."

TUESDAY, FEB. 9...Asiatic, 22, Albemarle-street, W., 4 p.m. Mr. A. B. Keith, "Pythagorus and the Doctrine of Transmigration."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. A. Macdonell, "The Architectural and Sculptural Antiquities of India." (Lecture II.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Professor Bertram Hopkinson's paper, "Heat-Flow and Temperature-Distribution in the Gas-Engine."

Cold Storage and Ice Association. (At the HOUSE OF THE ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.), 7½ p.m. Mr. C. J. Tabor, "Some Scientific Problems in the Preservation of Food by Artificial Refrigeration."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8 p.m. Mr. E. B. Osborn, "Canada's New Trans-Continental Railway and the New Lands opened up."

Horticultural, Vincent-square, Westminster, S.W., 3 p.m.

Faraday Society, in the Library of the Inst. of Electrical Engineers, 92, Victoria-street, S.W., 8 p.m. 1. Mr. Samuel Rideal, "Applications of Electrolytic Chlorine to Sewage Purification and Deodorisation by the Oxychlorides Process." 2. Mr. E. Sabersky, "A New Electrical Hardening Furnace."

Photographic, 66, Russell-square, W.C., 8 p.m. Annual General Meeting.

WEDNESDAY, FEB. 10...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. A. R. Colquhoun, "Bosnia-Herzegovina."

Japan Society, 20, Hanover-square, W., 8½ p.m. Professor M. Honda, "The 'Red-haired' Occidentals described by a Japanese Scholar in 1787."

Biblical Archæology, 37, Great Russell-street, W.C., 4½ p.m.

United Service Institution, Whitehall, S.W., 3 p.m. Colonel W. Watts, "Special Reserve and Militia: Their Respective Advantages and Disadvantages."

Auctioneers', 34, Russell-square, W.C., 7½ p.m. Mr. Graham Mould, "The Law of Distress Amendment Act, 1908."

THURSDAY, FEB. 11...Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Sir Frederick Bridge, "Dr. Samuel Pepys, Lover of Musique."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Archer, "The Revival of Modern Drama." (Lecture II.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Messrs. L. Andrews and R. Porter, "Use of Large Gas Engines for Generating Power."

Society of Architects, Staple-inn-buildings, Holborn, W.C., 8 p.m. Mr. G. A. T. Middleton, "Continental Gothic Detail."

FRIDAY, FEB. 12...Royal Institution, Albemarle-street, W., 9 p.m. Prof. H. A. Wilson, "The Electrical Properties of Flame."

Junior Institute of Engineers, Royal United Service Institution, Whitehall, S.W., 7½ p.m. Mr. Kenneth Gray, "Heat Transmission in Buildings."

Physical Society, Imperial College of Science, South Kensington, S.W., 8 p.m. Annual General Meeting. (Presidential Address.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Vernon-Harcourt Lecture.) Sir Whately Eliot, "The Design and Construction of Docks."

SATURDAY, FEB. 13...Royal Institution, Albemarle-street, W., 3 p.m. Sir Alexander Mackenzie, "Mendelssohn." (Lecture II.)

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FRIDAY, FEBRUARY 12, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 15th, 8 p.m. (Cantor Lecture.) LEON GASTER, A.M.I.M.E., "Modern Methods of Artificial Illumination." (Lecture I.)

WEDNESDAY, FEBRUARY 17th, 8 p.m. (Ordinary Meeting.) Monsieur YVES GUYOT, "The Commercial Relations of France and Great Britain."

Further particulars of the Society's meetings will be found at the end of this number.

PRESENTATION OF THE ALBERT MEDAL TO SIR JAMES DEWAR.

The Council of the Royal Society of Arts attended at Marlborough House on Thursday, the 11th inst., when his Royal Highness the Prince of Wales, President of the Society, presented its Albert Medal to Sir James Dewar, M.A., D.Sc., LL.D., F.R.S., "For his investigations into the liquefaction of gases and the properties of matter at low temperatures, investigations which have resulted in the production of the lowest temperatures yet reached, the use of vacuum vessels for thermal isolation, and the application of cooled charcoal to the separation of gaseous mixtures and to the production of high vacua."

The members of the Council present were:— Sir William H. White, K.C.B., LL.D., D.Sc., F.R.S. (Chairman), Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., Thomas Jewell Bennett, C.I.E., Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D., Sir William Bousfield, M.A., LL.D., Sir William Crookes, D.Sc., F.R.S., Sir Henry Hardinge Cunynghame, K.C.B., Hon. Sir Charles W. Fremantle, K.C.B., Robert Kaye Gray, Sir John Cameron Lamb, C.B., C.M.G., Sir Philip Magnus, M.P., Sir Boverton Redwood, D.Sc., F.R.S.E., Alexander Siemens, Carmichael Thomas, Sir William Hood Treacher, K.C.M.G., and Sir John Wolfe-Barry, K.C.B., F.R.S.

COUNCIL.

At the meeting of the Council on Monday, the 8th inst., the Hon. Richard Clere Parsons, M.A., was elected a member of Council in place of the late Dr. Francis Elgar, F.R.S.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

Tuesday, February 2, 1909; EARL CARRINGTON, K.G., G.C.M.G., President of the Board of Agriculture, in the chair.

The CHAIRMAN, in introducing the reader of the paper, said that he was one of the chief authorities on all subjects relating to wheat. Mr. Humphries was not only a practical miller, but a successful farmer, and was one of the greatest living authorities on the baking properties of flour. He was an enthusiastic investigator of the factors producing quality in wheat; he was the Chairman and the prime mover of the Home Grown Wheat Committee; and for six years he had issued a series of most valuable reports to the agricultural public. As a skilled and practical miller he appreciated scientific research, and the scientific workers warmly appreciated his aid. In the author they had a combination of science and practice, which would once more help agriculture at a critical period of this country's history; and he congratulated the audience on being able to listen to a paper by a man who had given so much time to a successful attempt to benefit the wheat producers of England.

The paper read was:—

THE PRODUCTION OF WHEAT IN THE BRITISH EMPIRE.

By Albert E. Humphries.

Sundry persons of diverse standing have ventured to utter prophecies concerning the possibilities or probabilities of growing in the British Empire sufficient wheat for its own requirements. A few years ago, Sir William Crookes called attention to the danger of an absolute scarcity of wheat, which in his opinion threatened the world, but he, more fortunate than Frankenstein, laid his own monster by the prospect of increased crops, due to the discovery of a cheap form of nitrogenous manuring. I am merely a miller, in constant touch directly and indirectly with all our sources of supply, and to my lay mind the problems are not whether the world or the British Empire can grow enough wheat for the needs of its inhabitants, but whether either or both can grow enough at prices equal to the low one of 30s. per quarter delivered to London—two essentially different propositions.

Without the application of recent scientific discoveries, I cannot conceive the possibility of an absolute scarcity of wheat. On an average of years a rise in the average price of wheat would bring into cultivation good lands, on which, because of their geographical position, it has not recently been profitable to grow wheat, or dry lands for which irrigation as a commercial proposition cannot now be entertained; or such a rise would tempt farmers in many parts of the world to adopt better methods of soil cultivation and manuring, whereby the yield per acre might be most materially increased. It seems to me, therefore, that the world can be assured of a sufficiency of wheat at moderate prices; it may even get a sufficiency at low prices with the aid of scientists. The botanist is showing us how it is possible to breed wheats more suitable to the very many varying requirements of each country or district, so that on existing wheatfields, without increased cost, it will be possible to grow much larger crops; he is showing us also how to diminish or eliminate the ever present ravages of plant diseases, whereby, without extra cost, the yield of wheat can be increased; he is finding or producing wheats which will thrive under unfavourable conditions of soil and climate, so that wheat may be grown without irrigation on huge tracts of land, where the rainfall is at present insufficient; or, by producing varieties which will grow and ripen more rapidly than existing ones, we may be able to produce wheats in districts where the time between two winters is now insufficient for the growth and proper ripening of a crop.

The chemist, too, is at work in many directions, notably on soil problems; the engineer is still reducing the cost of transport and perfecting methods of irrigation; these and other workers in many directions are all co-operating for the benefit of the increasing population of the world, which even now is something less than 40 per square mile.

I want to pass in review some of the conditions of wheat-growing in the principal sections of the British Empire. Let me deal first with

The United Kingdom.

Thirty years ago our population was about 34,000,000; to-day it is about 44,000,000—an increase in the period of about 10,000,000. In 1878 there were under crop and grass in Great Britain 31,854,532 acres; in 1907 there were 32,243,447 acres—an increase of, say, half per cent. (On this point I am referring to Great Britain, and not to the United Kingdom, because the complete figures for Ireland prior to 1887 are not available.) The average acreage of wheat for the five years 1878 to 1882 was 2,965,573; for the five years 1903 to 1907, 1,627,000—a decrease of, say, 45 per cent. In view of these striking figures, I have thought it desirable to set out in Table I.* how the increases and decreases of acreage under various crops and permanent grass about balance each other for the periods under review. It will be seen that decreases in the acreages of wheat, barley, beans, peas, turnips, bare fallow, and "other crops" are offset by increases in permanent grass, oats, potatoes, mangold, cabbages, and clovers. The returns for the same periods show an increase of over 1,000,000 cattle (18 per cent.), 350,000 pigs, 120,000 agricultural horses, and a small decrease in sheep.

In the five years 1878 to 1882 we produced an average of 9,382,424 quarters at home, and imported an average of 16,784,000 quarters of wheat per annum; in the five years 1903 to 1907 we produced an average of 6,605,521 quarters, and imported (net) 26,589,600 quarters per annum—an increase in imports of 9,805,600 quarters. Stated in another way, in the former period we produced 117 lbs. of wheat per head of the population, and imported 238 lbs.; in the latter period we produced 68 lbs. per head of the increased population, and imported 284

* The Tables are printed as an Appendix to the paper.

lbs. One rather remarkable point is shown by these figures. It will be seen that the total consumption per head of the population was 355 lbs. in the earlier period, and 352 lbs. in the later. It has been thought that the great increase in the production or importation of other forms of food, such as meat, vegetables, fruit, &c., would have reduced the consumption of wheat, but that is not so. No doubt millers nowadays produce less flour from the same quantity of wheat, and more wheat at the lower prices of recent years is used for poultry and cattle food, but the proportionate consumption of wheat for all purposes remains stationary. Some other striking figures concern the yield per acre. For the first period it was about 24 bushels per acre, for the later one 31½ bushels. The average "Gazette" price per quarter for the earlier five years was 45s. per quarter. for the later, 28s. 8d. per quarter. Within the last 30 years seedsmen have introduced varieties of wheat which, though worse in quality than the older varieties, yield larger crops, and this fact has had some effect on the average yield per acre, but it seems to me that the fall in price of wheat has, by a process of "selection," brought about the diversion of poor wheat land to the production in other directions of food for man. Clearly, it is *not* a case of land going out of use altogether, and I do not think that the diminution in wheat production is so important a cause of decrease in agricultural labour as most people imagine. For since machinery has been adopted for sowing, harvesting and threshing, wheat growing, except for a very few weeks in the year, requires practically no labour, and it is one of the cheapest crops to produce, whereas cattle keeping and dairy work mean steady occupation all the year round for the production and distribution of the produce. As matters now stand it will be seen that we have in the last few years been producing about 19 per cent. of our requirements, most of it in the eastern part of Great Britain, where the average rainfall varies from 22½ to 27½ inches per annum, against an average for the whole of Great Britain of more than 31½ inches.

I do not feel inclined to prophesy concerning the prospects of growing an increased acreage of wheat in the United Kingdom, but there are a few facts bearing on that problem which call for attention.

British wheat has been sold for many years past at substantially lower prices than the best foreign. To some extent this has been due to its containing so much more moisture. That cannot profitably be altered, and growers do not suffer from the mere fact of selling water at wheat prices. On most points of quality, well-harvested British wheats compare quite favourably with imported wheats, but in the point of strength, by which I mean the capacity for making large, shapely, and, therefore, well aerated digestible loaves, it is notably deficient. That deficiency has been accentuated, since, concurrently with the advent of stronger foreign wheats, seedsmen have introduced heavier cropping but "weaker" varieties. The relative price of English wheat has suffered accordingly. Millers, individually and collectively, for many years pointed out the results that would accrue from that actual and relative depreciation in quality, and they knew that unless country mills could obtain better wheats from their own localities, those mills, in the white-hot competition of flour made abroad or at home from foreign wheats, would go under, thereby restricting the best markets for home-grown wheat; but farmers and agricultural societies took no practical notice of those complaints and prophecies. It was believed even by agricultural scientists of high standing that it was impossible to combine maximum yield with high quality. Finally millers collectively, through the Home-grown Wheat Committee of the National Association of British and Irish Millers, initiated in 1901 an enquiry into the conditions affecting or governing quality, and have since received invaluable assistance from Professors Middleton, Wood and Biffen, of the Agricultural Department of Cambridge University, from Mr. A. D. Hall, of Rothamsted, and from other scientists.

Stated in briefest summary, the Committee has found after testing the effects of manuring, rotating of crops, and the effects of sowing and harvesting at various times, that it is essentially a problem for the plant breeder, that a very few among a great number of strong foreign wheats tested in England are capable of assimilating and utilising under our relatively unfavourable conditions of climate, those constituents which cause, or are correlated with, strength, and that by the application of Mendelian selection to hybridising the good quality of these few foreign wheats can, in a comparatively short time, be properly combined with the high yielding characteristics of our ordinary English wheats, thereby producing many ideal wheats suitable for all the varying sets of natural conditions

prevailing in different parts of the United Kingdom. The work is necessarily slow, but it progresses, and the Committee is confident that within a few years it will be possible to grow in England wheats of maximum quality with a maximum yield of grain and straw. Furthermore, if, with an increase in the use of motor cars, another market is wanted for straw, it may prove possible by the same processes of breeding and selection to adjust its qualities to the altered requirements, whether it be used for feeding purposes, replacing hay to some extent and thereby releasing some grass lands for wheat-growing purposes, or for paper making, or for the straw boards used in bookbinding and similar work. This means that the relative value of English wheat will advance.

It has been the custom for many years to say or assume that wheat-growing in England is unprofitable. Most farmers would have used that adjective in an absolute as well as in a relative sense. Thirteen seasons ago, I became the acting executor for a farmer in a rather large way of business in Surrey. He had been growing principally coarse vegetables for the London market, and entertained the current opinion as to wheat-growing, but he, like very many more, in spite of his great abilities as a practical farmer, did not keep accounts as to the cost of production for each crop, and expected wheat to carry more than its own share of the expenses incurred in a system of rotating crops. I at once started to ascertain the gross and net returns from each crop, and as a consequence have abandoned vegetable for corn growing. On an average of years I find the net return from the latter is better. Rothamsted has shown that the yield of wheat from manured plots can be maintained for more than fifty years of continuous wheat-growing on absolutely the same land, even if the manures used be "artificial." Science and practice have also shown that such manuring is good, and cheaper than the use of "farmyard" manure where the latter has to be bought and brought at considerable expense on to the land. Mr. Prout has published a summary of the returns from corn-growing at Sawbridgeworth, which has been carried on practically continuously for nearly 50 years. He has bought no manures but "artificial" and applied them annually. Including that expense, he gives the cost of cultivation for wheat, reckoning £2 0s. 6d. per acre for rent, rates, taxes, tithe and interest on capital, at £6 8s. 0d. per acre (a figure which agrees almost precisely with my own, ascertained before his were published) and the yield on an average of 25 years as 35 bushels of wheat and two loads of straw per acre. In bad years this has shown a profit, and on an average of 25 years with wheat at 31s. 9d. per quarter and straw at 25s. per load (43s. 4d. per ton) the substantial profit of over £3 per acre. Even if the straw were taken at a lower price for consumption on a farm, there would still be a profit more than equal to the total proceeds per acre in many parts of the Empire. Although I recognise that these variations from English current agricultural practice would not suit all soils and conditions to be found in England, it seems to me that corn-growing in this country cannot be deemed unprofitable in the absolute sense of the term, but it may not pay as well as other forms of agricultural production where land is not so suitable for wheat-growing. We have seen that the acreage of land under crops and permanent grass has been practically stationary for at least 30 years. I prefer to wait and see whether, with the aid of science and perhaps advancing prices, the acreage of wheat again increases at the expense of other crops or grass, or whether it can be grown on any of the 26 per cent. of the area of England and Wales at present uncultivated. It is so far satisfactory to see that wheat can be produced at a low cost per bushel as a consequence of our high yields per acre.

To show how much wheat we obtain from our various colonies, I have drawn up Table II. For the purpose, I have gone back fifteen years only, and divided that time into three periods of five years each. The figures are taken from the Agricultural Statistics published by our own Government, and as they are therein stated in cwts., I have retained that form of return in my Table. It will be seen that in the first of the three quinquenniums 12½ per cent. of our imports of wheat came from the British Empire, in the second, 19 per cent., and in the third, 34½ per cent. In 1908, the proportion received from "British Possessions," fell to 23½ per cent., for the wheat crops were poor or bad simultaneously in India, Australia, and Canada. The Argentine Republic came to the rescue with a record crop, and we received 29 per cent. of our total imports from that country.

AUSTRALIA.

Australia presents a most interesting set of conditions and problems to the investigator of wheat production. We see a huge area of which, as yet, only a small proportion is culti-

vated, more sparsely populated than any of the civilised countries of the world, a slowly increasing area under crop, a large proportion of that cultivated area under wheat, a very small yield of wheat per acre, and difficult problems of soil and climate, necessitating special and highly specialised investigation.

Tables III., IV., and V., taken from the *Official Year-Book of the Commonwealth* for 1908, give in summary the position as regards its wheat production and export. From Table III. it will be seen that the principal wheat-growing States in order of acreage are Victoria, New South Wales, and South Australia, that there has been since 1895 a great increase of area under wheat in New South Wales, a moderate increase in Victoria, actually small but relatively large increases in West Australia and Queensland, a decrease in Tasmania, and practically no change in South Australia. Taking a wider outlook, the progress of wheat-growing may be summarised as follows:—Between 1860 and 1876 there was a moderate increase, from 640,000 acres to 1,420,000, but in the five succeeding seasons a rapid increase carried the area up to 3,000,000 acres. Then for 15 years the increase was not large, the total for 1895-6 being about 3,750,000 acres. This was followed by another rapid increase in area, so that an average of 6,000,000 acres has been attained. For comparison with the growth of population, let us say that the 3,000,000 acres stage was reached in 1880, and the 6,000,000 acres stage in 1904. On December 31, 1879, the population was 2,162,343, and on December 31, 1903, 3,926,969, so that, although the increase in wheat acreage was arrived at by irregular stages, we find that in the period when the population had nearly doubled, the acreage under wheat actually did so. I cannot to-day stop to enquire into the causes of this growth. It is not, in the simplest form of the term, a question of price realised per quarter, for concurrently, there have been reductions in the costs of production, handling, and shipment.

Let us, in order to estimate the importance of Australian wheat production, get its figures into proper focus. Its total production constitutes about 2 per cent. of the world's crop. Since 1880 its acreage of wheat has doubled, representing an increased export of say 3,000,000 qrs., but in that period the requirements of the United Kingdom only for foreign wheat have increased about 10,000,000 qrs. For the sake of comparison, I have mentioned the United Kingdom, but it must not be forgotten that in the six years 1901 to 1906, only 70 per cent. of Australian exports of wheat came to the United Kingdom. The remainder went to Cape Colony, Natal, Chili, Peru, and other countries, including India.

The conditions of soil and climate in Australia are peculiar. We in this country regard some form of nitrogenous manuring as essential for the production of big wheat yields. Australian soils are as rich in nitrogen as European or American soils, and they seem to possess it in a form which the plant can easily assimilate. The nitrifying processes seem to go on with such rapidity that the wheat plant can get what it wants without the use of nitrogenous manures. This characteristic is particularly noticeable in the drier areas. Nor must it be forgotten that in wetter climates, a substantial proportion of the soluble nitrogen gets washed away by natural drainage. So it comes about in Australia that applications of nitrogenous manures, even to lands which have been in cultivation for many years, are rarely profitable, sometimes actually harmful. Potash and lime are abundant in most of the Australian soils, but their outstanding peculiarity is their low percentage of phosphoric acid, and the application of superphosphate is becoming or has become very general. It is interesting to an English farmer to note, that superphosphate costs more than twice as much per ton as it does in England, but whereas we use, say, three to five cwt. per acre, the Australian farmer has found it most profitable to use only 80 to 120 lbs. per acre, so that, as manuring in Australia at present means simply a small dose of one cheap manure, the Australian farmer has only to reckon on a small outlay under that heading.

The distribution of rainfall is peculiar. The capital cities of the States all have a good or great rainfall, but the wheat fields are almost exclusively in dry districts, and this fact brings in its train the necessity for obtaining by selection or hybridising, varieties of wheat suitable for this environment. When dealing with the United Kingdom I pointed out that wheat-growing is carried on principally in the eastern counties, where the rainfall is from 22 to 27 inches per annum. Farrer in one of his papers points out that by sowing a variety known as "Australian Poulard," which was originally obtained from Egypt, a farmer had succeeded in growing a crop far inland, in a year when the rainfall there was under five inches. This is an extreme case, but it may bring home to us the enormous difference in the problems imposed by Nature on the wheat grower. In

England we want wheats which will tiller well and throw up a great number of stems from well-developed roots. In those dry climates they want varieties which tiller sparingly, for a single set of roots seems unable to collect food-bearing moisture enough for more than a very few stalks. Our wheats generally have broad big leaves, and their large evaporating surfaces transpire a comparatively large quantity of water. Australian wheats, owing to lack of moisture, require narrow leaves and scanty foliage to keep down evaporation. Again, our wheats are nearly all slow and late ripeners; we reckon Fife an early ripener. Australians must have early ripeners, and reckon Fife much too slow in maturing for their purposes. If Australian wheats ripen slowly in excessively hot dry weather, the tops of their heads will be withered or blasted, and in a "rusty" year they will probably be damaged much more than early ripening ones. Again, we want big crops of good straw; there the straw is practically valueless, and whereas in the work of breeding for our conditions we have to provide long strong straw, they have found hybrids with short straw desirable. Australia was fortunate in possessing, in the person of the late William Farrer, a genius of the unassuming kind, who realised the necessities of the Australian case, and laboured to provide for them. In this he achieved great success, and it is extremely interesting to note how he recognised and stated many facts concerning the influences of heredity, which since 1901, as a result of the rediscovery of Mendel's laws and their application to wheat, have come to be recognised as part of a system upon which Nature works. The skilled botanist can now build up, in a comparatively short time, new ideal varieties which will remain true to type, and he now knows beforehand how to proceed and what to expect. Some of Farrer's best-known new varieties are Federation, Bobs, and Comeback; and if further experiences confirm results already achieved, they will bring about in Australia much improved results as to yield and quality. As regards quality, Australian wheats are already good and command good prices on our markets. I was interested in seeing in the Commonwealth Year-Book, page 306, the statement that in the home markets, Australian wheat is preferred to Australian flour, because it is advantageous to us to have the offal. This is true, but only part of the story. Australian wheat is clean, well-harvested, and makes good flour of a class, but though dry, the wheat is too soft to be ideal, and not strong enough according to the definition of the term I am using, for use, say, in London, by itself. An ideal flour can be made by grinding good Manitoban and Australian wheats together, and the Australians have lately produced new hybrid varieties, which, according to small samples, appear to be of that quality. As yet we have not obtained supplies of really strong wheat from hot, dry climates, but many old ideas about wheat are passing, and modern science, by providing new varieties suitable for specific peculiarities of soil and climate, is working wonders. So long, however, as the price of services rendered is based on cost, wheat, which in bulk is almost as easy to handle as water, will be brought here in preference to flour, and be milled as near to the points of consumption as economic requirements will permit.

To an English farmer the most striking point in connection with Australian wheat-growing is the way in which it is made profitable. Our average yield, as we have seen, is 31½ bushels per acre; theirs for the six years 1901-2 to 1906-7, including 1902-3, a year of disastrous drought, is only 9·03 bushels. According to the Commonwealth Year-Book the average export price of wheat for those six years or thereabouts was only 3s. 1½d. per bushel, which equals, say, 31s. 6d. c.i.f. per qr. delivered to London, from which must be deducted, say, 7d. per bushel for cartage to railway station and railway freight, so that the gross monetary yield per acre for the wheat works out at less than 24s. per acre on the farm, while the straw has no monetary value. In England, the gross return for wheat and straw works out at from, say, £7 to £10 per acre. In Mr. Prout's case, we have seen that rent, rates and taxes cost £2 0s. 6d. per acre per annum, which seems a full amount for English wheat growing land, but even after allowing for that, the Australian figures are startling by comparison. Even under their conditions there must be something in the nature of a rent-charge, for if a settler obtained land free, he would have to provide buildings, fences and similar necessities, and the interest on that outlay is, at any rate, something.

Of course, I realise that a big yield is not of itself the great aim of the farmer. It is simply a means to the end of profit-making, and if by a small outlay, under precarious conditions of climate, an Australian farmer can make a profit out of an exceedingly small yield, all honour to him as an acute business man; but I

have been very curious to see how it is done. We have seen he economises on his manure bill, and a lot of fallowing is done, which, under Australian conditions, means only a relatively small annual charge. Seed is cheap, and machinery largely used in cultivating. As straw is of no value, the heads are stripped and threshed at one operation in the field. We hear of multiple-furrow, jump-stump ploughs, which if very different to our methods of producing big crops, seem to suit Australian conditions. So it comes about that the Agent-General for New South Wales is able to tell me that "leaving out of consideration rent, interest, and carriage, the cost of growing wheat in New South Wales is approximately, on large farms with first-class appliances, 15s. 6d. per acre; on moderate sized farms with good appliances, 20s. per acre; on small farms, 27s. per acre." That tells a further tale. Queensland, with a yield of 12·3 bushels per acre against 9·03 for the whole Commonwealth, has to import wheat or flour for its requirements, and only 20 per cent. of its cultivated area is under wheat. Tasmania, with the relatively fine yield of 19·3 bushels per acre, has only 13·4 per cent. of its cultivated area under wheat, and in 1906-7 had only 32,808 acres under wheat, as against a maximum of 73,270 in 1865-6, which means that it also imports wheat or flour. So far as I can gather, the essential difference between these States and the other parts of Australia is that, in the two former the holdings are smaller, and the figures given above provide some indication why other forms of production are preferred. We have seen also that the acreage in South Australia is stationary. I note that its yield per acre for the six years 1901-2 to 1906-7 is especially low—only 7·36 bushels per acre. Effect and cause are in juxtaposition. In West Australia the acreage under wheat is even now not large, but it has been trebled since 1902. In other words, it has risen from 92,000 acres in 1901-2 to 279,000 in 1907-8, and it is estimated that there are about 20,000,000 acres in this colony upon which wheat can be grown at a cost of 20s. per quarter on the farm, which equals, say, 30s. per quarter delivered to London. In recent years the value of such wheat has been higher than that delivered here and this rise in price has made wheat-growing in West Australia profitable, a fact which has been quickly reflected in the acreage of wheat. The finding or breeding of a variety or varieties which will thrive on a small rainfall will make an enormous difference to the acreage of wheat in this colony, for though its climatic conditions are more reliable than those prevailing in other parts of Australia, there is a great tract of territory just outside its present wheat-growing area, in which low rainfall is the hindrance at present to wheat-growing. It is worth noting that the West Australian Government offers "to advance 75 per cent. of the value of wheat on the shipping certificate."

In New South Wales, where at present the area under wheat is about 2,000,000 acres, there are, in all, over 18,000,000 acres of good wheat land.

Canada.

Like Australia, the Dominion of Canada possesses an enormous extent of territory with an extremely small population per square mile. Its land area is 3,745,574 square miles, and its population in 1907 was estimated to be 6,500,000, so whereas the United Kingdom with its 44,000,000 people has nearly 600 to the square mile, Canada has less than two to the square mile.

Each province grows some wheat: British Columbia, Nova Scotia, New Brunswick, Prince Edward Island each a little; Quebec more, about equal to the quantity grown in the East Riding of Yorkshire; Ontario still more, about equal to the quantity grown in Lincolnshire and the West Riding combined; the North-West Territories again more and Manitoba most of all. The average annual total yields of wheat in quarters for the last five crops is for the Dominion 12¼ millions, which equals 3¼ per cent. of the average world's wheat crop. For the United Kingdom the corresponding yields are 6¾ millions, for the Argentine Republic 21 millions, for the United States 76 millions. At the last complete census of 1901, Manitoba and the North-West Territories provided 80 per cent. of the acreage under wheat in the Dominion of Canada, and it is in that part that the great development has taken place, and is likely to continue.

I do not think we ought to under-estimate the difficulties confronting the wheat-grower there. It is not an ideal wheat-growing country, in which anybody, whatever his experience, can scratch fertile soil, and produce abundant crops of wheat sufficient to maintain the farmer and his family in conditions of affluence and physical comfort all the year round. It is quite safe to say that no responsible person has ever said so, but the proper and effective manner in which the advantages of the North-West have been so

persistently put before the public under the very comfortable conditions of exhibitions and public demonstrations, has tended to exalt the advantages and somewhat obscure the disadvantages of Canadian wheat-growing, so I want to examine the subject from an independent standpoint. First of all, I must express wholehearted admiration for the way in which the difficulties of the situation have been, and are being, tackled.

Wheat is not indigenous to Canada. The variety known generally as Red Fife, sometimes as Scotch or Glasgow, forms, directly or by its progeny, the bulk of the wheat grown in the North-West. It was introduced about 1842. A Scotsman sent to David Fife, a settler in Ontario, some wheat which had been imported into Glasgow from Dantzic. David Fife sowed some of it on its arrival in spring, and only three ears, which grew apparently from a single grain, ripened. In recent years it has been established, that this Fife wheat is simply a variety known in Europe as Galician; so we must suppose that at least one stray grain of that variety found its way into the cargo of Dantzic, which is quite a different kind and matures slowly. From those three ears has come that splendid wheat for which the Canadian North-West has become so famous.

We have seen that the great trouble in Australia is the smallness of the rainfall in the wheat-growing districts. There is a semi-arid district of 80,000 square miles, or, say, 50,000,000 acres, in the south-west of Assiniboia and the south of Alberta, in which the rainfall measured at Calgary, Medicine Hat, and Swift Current averages about 15 inches per annum.

At Winnipeg the average annual rainfall is about 16¾ inches, of which 12½ inches, say, 75 per cent., fall in April, May, June, July, and August. At Qu'Appelle the annual rainfall is under 11½ inches, of which 9½ fall in the months specified. At Prince Albert the annual rainfall is under 11 inches, but 8¾ fall in those months.

From these figures it will be seen that in the semi-arid area the total annual rainfall is not so low as in some of the better wheat-growing districts, but the trouble is that there is not sufficient in those months in which wheat is growing. In our own eastern counties the average annual rainfall is 22¾ inches, nearly double the average quantity for the Canadian North-West, but in the five months April-August, inclusive, our eastern counties get only 9¾ inches against Winnipeg's 12½, Qu'Appelle's 9½, and Prince Albert's 8¾. No doubt the extraordinarily low precipitation in the winter months obviates the loss of much nitrogen from the soil by drainage, but clearly it cannot be a low summer rainfall which causes the high quality of the Manitoban wheats. Although in the same latitude as England, frost is the great enemy to wheat-growing in the Canadian North-West. The country may be described as a plateau of three sections rising from east to west. The mean elevation of the most easterly of these three sections, in which Winnipeg is situated, is about 1,000 feet. The mean elevation of the second section is 1,600 feet, and of the third 3,000 feet. At Winnipeg the average mean highest temperatures are all below freezing point for November, December, January, February, and March, and the average mean lowest temperatures are well below zero for December, January, and February, and practically zero for March. Professor Mavor divides the calendar into 4½ weeks spring, 20 weeks summer, 8 weeks autumn, and 19½ weeks winter.

Wheat is a very hardy plant, and in Alberta a little is now sown in the autumn, but it may still be said that wheat in the North-West is sown in April, sometimes in the last week of that month, and cut in August. In 1907, the spring was late, and as a consequence, wheat sowing was late. Unfortunately, some frosts came early in the autumn or at the end of the summer before the wheat was fully formed in the ear, and the result was disastrous. The wheat was "frosted" to a great extent, very little would grade higher than No. 3 Northern, and large quantities were sold in Europe as "Feed" or "No. 2 Feed" at, say, 22s. to 25s. per quarter delivered to our ports, when best wheats were selling at 40s. and upwards. This was the worst case known, but there is a very real and constant risk of damage by early frosts. In the crop years ending August 31, 1905, 1906, and 1907, 34 per cent., 18 per cent., and 22 per cent. respectively, of the cars of grain inspected at Winnipeg, failed to pass inspection as fit for the four highest grades of Manitoban wheat, and a good deal of the damage was due to "frosting." This year we are getting substantial quantities of Manitoban wheat similarly affected. In England while we are quite content to grow late ripening wheats, and consider Fife an early-ripening one, the Canadians have been striving to produce wheats equal in quality to Fife, which shall grow and ripen in

an even shorter period, and they have good reason to be pleased with their success in producing some, which require five to nine days less than Fife for their whole period of growth from sowing to cutting.

It is said that Canada will grow all the wheat required for the increasing importations of the United Kingdom. Let us look at the principal conditions which have a bearing on that statement. The reputation of Canadian wheat is deservedly high. In buying Russian wheats the importer bases his ideas as to value on a sample more or less accurately representing the actual wheat offered. In the United States and Canada, systems of grading have been established, and each lot of wheat as it is received into an elevator is examined, and graded according to quality. The identity of that particular lot of wheat is no longer preserved. Operators buy wheat on certificate, and the mere production of the certificate is held to be sufficient evidence that all the requirements of the deal have been complied with, so far as quality is concerned. It is obvious that the selling value of the wheat depends to a considerable extent upon the confidence with which such certificates are regarded. European buyers regard United States certificates with suspicion, for the arrangements controlling their issue are far from perfect; but the reputation of Canadian grading is deservedly high, and the best grades of Manitoban wheat command absolutely maximum prices as a rule. We have seen that a substantial, sometimes a large, proportion of Canadian wheat is of inferior quality, but the authorities show no disposition to "debase their currency," if I may use the simile. If the quality be poor it is graded accordingly, and the confidence which such honest action inspires in buyers is reflected in the relatively high prices paid for Canadian wheat. I cannot discuss to-day the advantages and disadvantages of any system of grading, but undoubtedly the marketing of the wheat in large quantities is facilitated thereby.

The Canadian arrangements for storing and transport are also admirable. A London miller, severely handicapped by exorbitant and grossly unfair dock charges for handling bulk wheat, regards with envy and admiration the rates in force at Canadian Public Terminal Elevators, by which receiving, handling, cleaning, delivering, and storing grain for fifteen days, including fire insurance, costs ¾c. per bushel, say, 1s. 1½d. per ton. The average Canadian railway car holds 134 qrs., more than three times as much as our English trucks. Everything seems to an Englishman designed to facilitate transport. From Winnipeg or other interior points to the terminals at Port Arthur or Fort William wheat is moved by rail. From these ports, it can be taken to Montreal, all the way by water, between the end of April and beginning of December, and Professor Mavor puts the cost of such transit at, say, 1s. 5d. per quarter. An all-rail transit, Winnipeg to Montreal, costs 6s. per quarter, or about one farthing per ton per mile. In the winter months, wheat has either to be stored, or moved by the much more expensive rail transit to St. John, or a United States port, costing about 5s. per quarter for that part of its whole journey. The freight and handling charges on wheat for export consequently vary considerably, but I think it may be figured at, say, 9s. per quarter for its long journey to London, a cost which, of itself, indicates how cheap the facilities provided are. If, therefore, average quality Manitoban wheat realises 30s. (c.i.f.) delivered to London, it would be approximately correct to say that the farmer in the Canadian North-West would obtain about 21s. per quarter for his wheat at the local elevator.

I cannot enter into any detailed examination of the cost of production. Professor Mavor puts it at about 16s. 8d. per quarter, exclusive of storage charges, provided the farmer gets a fair yield, and in his opinion this covers the "actual cost, plus a small amount for land and improvements (rent) and profit (wages of superintendence)." Mr. Herbert Grange, the author of "An English Farmer in Canada," has put the cost at 45s. per acre, which, at 18 bushels per acre, equals 20s. per quarter. Some years ago I was engaged in a controversy as to the cost of growing wheat in the North-West of the United States, and growers who had farmed in the Red River Valley for 13 years, and were then farming in six different counties, said that my figures were too low. Including an item for something in the nature of rent, and others for seed, cultivations, harvesting and threshing, they put the cost at 36s. per acre, which covered one summer fallowing in five years. The best Canadian practice is to allow one-third of the cultivated land to be fallow in summer, but that means a larger yield per acre, so the cost per quarter given above has confirmation in these United States figures. I think, therefore, that we may take 17s. per quarter as the approximate cost of production, which equals

38s. 3d. per acre. Let us look at the yields per acre in grain and money.

The high quality of Manitoban wheat at its best is not evidence of the soil's high crop-producing power, for the best wheat as regards quality produced at Rothamsted comes from the continuously unmanured plot with its relatively low yield per acre. The soils of the Canadian North-West vary a good deal; it must not be assumed that all are suitable for competitive wheat-growing. One most important inducement to grow oats rather than wheat is that they mature in seven to fourteen days less time than wheat; another is, that the yield of oats per acre in Manitoba is twice as much as that of wheat.

In Manitoba, of the land under grain crops, the percentages under wheat and oats have for many years remained constant; in other words, the acreages under these two cereals increase at the same proportionate rate. In the Territories, the acreage under oats increases faster than the area under wheat.

Table VI. shows, with other particulars, the average yield per acre in the Canadian North-West. This compares favourably with the yield of spring wheat in the United States, which is only 13½ bushels, very favourably with Australia, but is much lower than the average yield (31½ bushels) in the United Kingdom. If, when Canadian wheat is worth 30s. (c.i.f.) per quarter in London, we take the average of 18 bushels at 21s. per quarter delivered to the local elevator, and ignore straw value, we get 47s. 3d. as the gross money return per acre for growing wheat in the Canadian North-West. The cost of production we have taken as 38s. 3d. per acre. This shows a profit, and to that extent wheat-growing is attractive. But I think a few more points should be taken into consideration. The average Canadian farm is not large. In Ontario, it was at the 1901 census only 115 acres; in the North-West it was under 300 acres. We have seen that the best Canadian practice is to allow one-third of the cultivated land to be fallow each year. If the full profit be earned on 200 acres the annual amount would be £90. This is not to be despised, but having regard to the risks involved, it reminds one of the distinction drawn between making and saving a fortune. With a population of, say, six per square mile in Manitoba, including the towns, and less than two per square mile in the Territories, the opportunities of spending much at or near their homes are not great, and the life of a farmer who specialises on corn-growing can appear attractive only to those fond of a very quiet one, in very cold, dry weather. I asked the head of one of the great United States milling concerns how the farmers growing wheat in the North-West of the United States liked the life and work with wheat at 30s., delivered to London. He replied that they liked it immensely, but further enquiries brought out the point, that the result was by comparison with the hardships they, largely emigrants, had endured in the countries they came from. Professor Mavor, writing in 1904, said that "probably not more than 50 per cent. of the present population of Manitoba and the Territories together are of strictly British origin." The remainder were largely Germans, Russians, French, Austro-Hungarians, Half-breeds, and Indians.

I have twice already mentioned a point in connection with wheat-growing which is frequently overlooked. In the Canadian North-West sowing is done in April, the harvesting in August and September. Some ploughing is done in the autumn, and wheat can be delivered to the elevators in the dull season, but the great work of wheat-growing, necesitating labour from sources outside the farmer's own establishment, is done in four to six weeks. This is an old trouble. Prior to the invention of the self-binding harvester, it greatly restricted the area of wheat production, and the difficulty of getting labour for so very small a proportion of the entire year will no doubt operate to restrict the indefinite extension of wheat-growing, as the sole or an important means of agricultural production. Professor Mavor estimated that 180,000 "rural persons" would be required to secure a continuous yield of 6¼ million quarters of wheat per annum. We have seen that in Australia the production of wheat doubled when the population doubled. I cannot now enquire to what extent the same conditions are likely to govern production in Canada, but it is patent to all that Canada does not mean to live for wheat alone. She has mines, fisheries, forests, manufactures; she can produce oats, barley, fruits, cattle, butter, bacon, and other good things in abundance; she has a great future before her; she has enormous areas of uncultivated land capable of cultivation, but whether she will specialise on wheat-growing, competing, for instance, with Argentina, which in the last 20 years has increased its area under wheat more than twice as fast as Canada, remains to be seen.

Twenty years ago it seemed that California had a great future before her as an exporter of cheaply-produced wheat, but she has diverted her agricultural production into other channels. With that striking case in mind, I am strongly disinclined to prophesy concerning the possibilities of wheat-growing in Canada or on the sister but different point as to how much she will be able to spare for export, but am content to have set forth some points with the object of getting facts into focus, and now finally to specify what she has already done as a wheat producer and exporter. Table VI. shows how the total crop of the Dominion and how her exports have increased, and incidentally, how the production of wheat in the older provinces has decreased. In the five years 1893 to 1897 inclusive, the United Kingdom imported an average of 22,684,000 quarters, of which Canada supplied 5½ per cent.; in the years 1898 to 1902, the United Kingdom imported an average of 23,357,000 quarters, of which Canada supplied 9 per cent. In the five years 1903 to 1907, the United Kingdom imported 26,951,000 quarters per annum, of which Canada supplied 10½ per cent.

INDIA.

In the production of wheat, India presents many points of striking dissimilarity to Australia and Canada. We see the same vast areas and liability to drought and rust, but there the principal points of resemblance cease. In Australia and Canada, only a relatively small proportion of the total area is as yet under crop: in India only about 20 per cent. of the net area is described as "cultivable waste other than fallow." In 1901 Australia had a total population of about 4 millions, Canada about 5½ millions, and India 294 millions, of whom nearly 192 millions were dependent on agriculture. This means that, whereas in Australia and Canada the population is less than 2 per square mile, in India it ranges in the principal wheat-growing areas from 67 in the North-West to over 400 per square mile in the Indo-Gangetic Plain West. According to the census of 1901 there were over 106 millions under the heading rent-payers (tenants) against 4 millions under the heading farm servants, and 29 millions under the heading of field labourers. Obviously, therefore, we have in India quite a different set of agricultural conditions from those we have been considering. In Australia, over 60 per cent., and in North-West Canada about 65 per cent. of the cultivated area is under wheat; in India only about 10 per cent. In the two former countries, wheaten bread is a principal article of diet; in India, fermented bread seems to have been unknown prior to the advent of Europeans. Even now, wheat is an important article of food in the Punjab only, and there it is generally consumed by the natives in the form of coarse cakes toasted by the side of an open fire.

This point is more important than it might appear to be, for the wheats which yield flour better suited for British consumption do not suit the native requirements so well as the varieties or types of wheat grown in large sections of the country. We used to get a large proportion of Indian wheat from Calcutta and Bombay, but in recent years the export trade has been confined principally, indeed almost exclusively, to Karachi. In Table VII. I have given detailed figures concerning the principal wheat-growing districts. From them it will be seen that the Punjab, including the North-West Frontier Province, heads the list of wheat-producing districts, and shows a substantial increase in the area under that crop. Take into consideration also that the population there equals only 67 per square mile, and the growth of Karachi as a wheat-exporting port is explained. Of the Punjab's total cropped area, one-third is usually under wheat, and it will be seen that on an average of the last five years, including the North-West Frontier province, it equals 34 per cent. of the total area under wheat in India. Next in importance as a wheat-producer come the United Provinces. There wheat occupies about 20 per cent. of the total area under crop, equalling 25 per cent. of the total Indian wheat acreage These two districts, the Punjab, including the North-West Frontier Province and the United Provinces, provide, therefore, 59 per cent. of the total wheat-growing area of India, and a very much greater proportion of the quantity exported. A long way behind the districts mentioned come the Central Provinces. Of their total cropped area about 13 per cent. is under wheat, which equals 11 per cent. of the total Indian wheat area. Then, in order of acreage under wheat, come Central India, including Rajputana, Bombay and Sind, Bengal, in which only about 2 per cent. of the total cropped area is under wheat, Hyderabad, East Bengal, and Mysore.

It will be seen, therefore, that in India as in Canada wheat for export comes from the North-

West. The point which commands first attention is the increase and quantity of land there under irrigation. Sir George Watt says that "fully half the wheat area of the provinces named (Punjab and the United Provinces) is ordinarily under irrigation wheat," and the increase in the irrigated area is the principal cause of the increase in wheat-production there.

The man in the street regards India as a very hot country, but in the North-West, apart from the hills, the weather in winter is cool or actually cold, and Sir George Watt says that sometimes much harm is done to grain by frost in ripening—a repetition seemingly of Canadian conditions. But the similarity is superficial only. I gave my authority for the statement, for we have never seen in England wheat "frosted" as Canadian wheat not infrequently is. It seems to me that such mishaps to the wheat crop may be likened to English late spring frosts such as those which we had last year, when snow fell at the end of April, or in the year when the "Derby" was run in a snowstorm. Such misfortunes damage the life and yielding capacity of the plant, but do not actually damage the grain itself. In the north-west of India as in England, sowings are commenced in October, but whereas in England the plant after an autumn growth does little more growing till April and ripens off in a time of decreasing temperatures occupying nine to ten months from sowing to harvest, in the great wheat-growing districts of India the corn is harvested in the late winter or spring, in a rapidly-increasing temperature. Cutting begins in February in Berar, in the beginning of March in the Central Provinces, in March and April in the United Provinces, and in the latter part of April and May in the Punjab. This means that in India from four to seven months are required for the entire period from sowing to harvest. In Mysore, a wheat known as "Jave Godhi," which seems to be "spelt," is sown in May or June, and harvested three months later. This last-mentioned fact is of no importance to us to-day, except to illustrate the great diversity in species and conditions of growing found in India. In some parts of India wheat is grown principally in rotation with leguminous plants, such as gram, or in rotation with cotton or maize, or millet, but in the Punjab, both on irrigated and unirrigated lands, wheat follows wheat for a succession of years, with an occasional whole year's fallow, or an alternation with some summer crop. One point in cultivation which seems extraordinary to an English farmer is the great number of ploughings. In the Punjab, if wheat follows maize, the land gets three or four, if it follows a fallow it gets eight or ten. In the United Provinces the land is ploughed, on an average, about eight times for wheat. I dare say these ploughings are not very thorough according to our English ideas, and it is said to be difficult or impossible to find a pebble, however small, on a journey of 2,000 miles, from the Bay of Bengal, up the Ganges, and down the Indus to the mouths of the Indus, but the number of ploughings, undertaken, I imagine, for the conservation of water in the soil, make this impression on my mind. I certainly would not venture to make any estimate of the cost of production in India, and the only figures on that point which I have seen concern Khandesh, where it is put at 14s. 7d. per acre on unirrigated land; but if the 14s. 7d., which reminds one of the Australian figure for big farms which I have given, includes many ploughings, what would the cost be if only one good one, or, perhaps, two were required, as in England, Australia, or Canada? The quantity of seed used per acre varies from 40 to 140 lbs. per acre, and the yield depends largely on whether the land is irrigated.

In the Punjab the average yield per acre is about 10·7 bushels for unirrigated and 15½ for irrigated land, with an average for the province of 12·8 bushels. In the United Provinces the yields are 13·3, 20·8, and 17½ bushels respectively. In the Central Provinces the figures are 9½ bushels for unirrigated and 15·4 bushels for irrigated land. The highest figures I have seen concern Ajmir-Merwara, of which it is said that "the out-turn, if the crop be manured and irrigated, is about 34 bushels" per acre. I suppose, however, that the figures on this point of most interest to us are to be seen in Table VII., where the average yield for the last five years from 26,739,000 acres is 7,991,000 tons, or 11·16 bushels per acre.

The Indian Government is doing valuable work in studying the problems concerning wheat production. The most important work for scientists is to find or breed varieties of wheat which shall be suitable as regards type and quality to local and export requirements, to see that these varieties are drought-resistant, and, perhaps, above all, to see that they are rust-resistant. In all wheat-growing countries, even in England, this rust problem is extremely important; in some, as we shall

see later on, its claims are paramount. In India it concerns principally the triangular area enclosed by lines uniting Bombay, Simla, and Calcutta, and in this area the losses from rust alone have been estimated at not less than two millions sterling per annum. In the Punjab the ravages of the disease are not so great, because of its dry climate and soil, but on the increasing area of irrigated land, the heavy floodings will probably bring about an increase of the losses from rust. This rust question is so important that I must refer to it again briefly later on. For the present all I need say in connection with it is, that Durum wheats are grown to a large extent in districts liable to it. The natives like Durum wheats for use as food in preference to varieties of the *Triticum vulgare* type, and the Durums are better drought and rust-resisters than ordinary wheats.

I have no ambition to be a prophet in any matter: most certainly I do not wish to be one in connection with the production of wheat in India. It seems to me quite impossible to foretell what India can do in the way of exporting wheat. The discovery or breeding of drought resistant wheats will no doubt help the crop per acre, probably the acreage under wheat. So will the further extension of irrigation, so will the recent discoveries as to the prevention of rust, and so will any means that will make wheat growing more certain in its results; but work in these directions is not so certain to result in an increase of area under wheat in India as it may and probably will elsewhere. In India an increase of wheat-production does not depend on an increase of population, for the necessary population is already there, and we have seen that the area of cultivable, but at present uncultivated, land is not large. In Australia or Canada it is largely, but not exclusively, a question of cereals or nothing; in India, the grower in large districts has many strings to his bow, sufficient to make an enormous difference in the surplus for export over and above native requirements. Table VII. also shows that on an average of the last five years only 16 per cent of the total crop has been exported. Sir George Watt, in "The Commercial Products of India," says that "if wheat displaces any crop it would be cotton, certainly not the food grains of the people." In the eighties, when prices were fairly high and ocean freights falling, the exports of wheat from India went up till in the one season, 1891-2, over 7,000,000 quarters were exported. Then came a collapse in prices, and with that a sufficient diminution in the acreage under wheat, especially in the Central Provinces, to carry the exports down to small or very small quantities. Table VII. shows the history of acreages, crop, and exports since then. With a remarkable increase in area and a big yield per acre in 1903-4, the exports went up so much that in 1904 the returns for the United Kingdom (see Table II.) show that India headed our list of wheat imports, the quantity being substantially more than those from Australia, New Zealand, and Canada combined. Unfortunately she has not maintained that position owing to smaller crops, and drought has brought her surplus for export down to very small figures in the current Indian fiscal year. It is to be regretted that we cannot rely on a regular supply of large quantities of wheat from India.

On one important point she has immensely improved her position. Until recently Indian wheat was shipped in a disgracefully dirty state. On May 31st, 1889, following a conference at the India Office on the subject, Mr. (now Sir) John M'Dougall read a paper before this Society, the burden of which was the improper or fraudulent admixture of dirt and extraneous matter to wheat. The abuse gradually got worse under pressure of competition in price, until something had to be done to stop the shady ways of the middlemen. So it came about that in 1906-7, I am glad to say during my term of office as President of the National Association of British and Irish Millers, concerted action was taken by shippers, merchants, and millers, by which the admixture of dirt, barley and other extraneous matter has been actually stopped or brought within small limits. Practically all Indian wheats for export are now sold and bought on terms whereby, under proper and specified conditions, each bulk of Indian wheat is sampled on arrival at our ports, and the samples are analysed to ascertain the percentages of dirt, barley and extraneous matter contained in them. Barley, pulse, and other feeding stuffs are allowed without deduction up to 2 per cent., but over that figure they have to be reckoned and paid for at half the price of wheat. Receivers are also entitled to deduct from their invoices the value of all dirt, non-farinaceous seeds, and other extraneous matter reckoned at wheat prices, and if there be more than 2½ per cent., the deduction for the percentage over that figure can be made at double the wheat price.

New Zealand.

The production of wheat in other parts of the British Empire can be sufficiently reviewed in a few words.

Since December 31st, 1893, the population of New Zealand has increased by about 250,000. The average yield of wheat per acre for the five years 1893 to 1897 was 23½ bushels; for the five years 1903 to 1907 it was the particularly good one of 33 bushels, yet the land under wheat decreased from 255,321 acres in the former period to 222,373 acres in the latter, and the exports, which in the former period averaged 84,704 quarters per annum, fell in the later period to 47,874 quarters. At present about 75 per cent. of the wheat produced in New Zealand is grown in the "provincial district" of Canterbury. In quality, New Zealand wheat resembles English at its best. It is estimated that there are 13,000,000 acres in the North Island and 15,000,000 in the Middle Island fit or capable of being made fit for agriculture. Of these 28,000,000 acres, about half are under sown grasses, crop, fallow, garden and orchard, but there are only about 650,000 acres under grain of all kinds. There were in 1906, 72,338 occupied and cultivated holdings over one acre in extent, averaging about 200 acres each. We have seen, in reviewing Australian conditions, that in States where holdings are small, like Tasmania and Queensland, farmers do not specialise on wheat-growing, and we see the same state of affairs in New Zealand.

Cape Colony.

Cape Colony produces from 200,000 to 300,000 quarters of wheat per annum, which equals about one-fifth of its annual requirements. Owing to the existence of a protective duty, the price of wheat in the colony has, for several years, been more than 40s. per quarter, and there are large areas in which rains are regular, and the soil suitable for wheat production. The great hindrance to an extension of wheat-growing is rust. Varieties which are, in a high degree, rust-resistant in their own countries, such as the Australian Gluyas, Bobs and Jonathan, are in Cape Colony badly affected. An Italian variety, called Rietti, seems to have done well in very recent years, but its quality is not good. This, however, as a result of Professor Biffen's discoveries, is no hindrance to its use as a parent of rust-resistant varieties, as we shall see later on. Within the last fortnight I have heard of another variety, said to be like Talavera in appearance, and obtained by selection in South Africa, which appears to be highly rust-resistant, or actually rust-proof, so we may hope that the day is not far distant, when rust, as a paramount hindrance to wheat production in South Africa, can be eliminated. At present, the South-West and Queenstown Provinces are the principal wheat-growing districts of Cape Colony, and wheat does well near the sea coast in the south of the colony. In the Karoo and the North-West very heavy crops can be obtained under irrigation, but where irrigation is practised, other crops give better results than wheat. The colony obtains its imported supplies mostly from Australia, but a moderate quantity was obtained from Argentina and the United States in 1907.

Natal and Orange River Colony.

In Natal and the Orange River Colony very little wheat is grown, though climatic conditions in Basutoland, and in certain parts of the upland districts of Natal, are suitable for wheat growing. The 1907 Statistical Year Book for Natal gives the total acreage of wheat grown by Europeans as only 370 acres, and the crop as 3,174 bushels, from which it appears the yield per acre is very small also. The third annual report of the Orange River Colony's Department of Agriculture makes no mention of the acreage under wheat, but it is known that before the war a considerable quantity was grown in the eastern districts of of the colony. In both States experimental work on wheat is being done, but the favourite cereal is maize, of which Natal is beginning to export substantial quantities of first-rate quality. In addition to rust, the Orange River Colony has to deal with the pests of locusts and a little insect known as the wheat-louse, which "has on several occasions cost the colony the loss of nearly the whole of its wheat crop."

Transvaal.

Only a very small quantity of wheat, say, 40,000 quarters per annum, is grown in the Transvaal. The yield per acre appears to be good; indeed, it is reported that extraordinarily large yields per acre can sometimes be obtained on very rich land, and the price of wheat in the Transvaal is high. But the great hindrances to larger wheat production are rust and drought. Rust is the great and overwhelming difficulty which the Transvaal wheat grower has to face. Its attacks are in some seasons more severe than in others,

sometimes they begin earlier in the season, and are, therefore, more deadly than in others, but the pest is ever present. It affects wheat in low-lying areas more than in higher ones, so it has been found possible to grow spring-sown wheats on the high veldt. The Australians have found that very rapidly maturing wheats are able to resist its attacks with more success than slowly maturing ones, and the same principle applies both to winter and spring sown wheats in the Transvaal.

Drought, the other arch-enemy to wheat growing in the Transvaal, has had so potent an influence, that until recently, substantially the only wheat raised there was winter wheat grown under irrigation sown in May or early June, and harvested in October or November. The quantity of irrigable land in the Transvaal is very limited and oat-hay competes with wheat for it. However as lucerne is to some extent replacing oat-hay the area of irrigated land available for wheat-growing will probably increase. At present the principal centres for irrigated wheat lands in order of importance are—Marico, Rustenburg, Lydenburg, Potchefstroom, and Pretoria. In the United States, Canada, and Australia the farming of "dry land" has received special attention, and in the Transvaal also by adjusting methods of cultivation and by finding or breeding varieties of wheat better suited to such lands the production of wheat may be increased. At present the quantity produced in the Transvaal is very small, quite insufficient for its own consumption.

Rhodesia.

Wheat is grown to a very limited extent in Rhodesia, although its value in that country ranges from 60s. to 75s. per quarter. The precipitation of moisture in the wet season, or summer months, extending from October to April, is usually sufficient to grow cereal crops without irrigation, but rust is the chief factor against the successful cultivation of wheat in that period. It can, however, be grown in the long dry season, April to October, under irrigation, but that means a large capital expenditure, so very few Rhodesian farmers are able to grow wheat at all. The acreage under wheat is being gradually increased, and experiments are being made with the object of discovering a wheat which is sufficiently resistant to rust to insure its being successfully grown during the wet season. Should such a variety be discovered the production of wheat would in a few years be very largely increased, and instead of importing wheat, wheaten flour and bran to the value of nearly £40,000 per annum, Rhodesia would probably be able to export to the other South African States.

British East Africa.

Through communications with a young Scotch miller, who is settling in British East Africa, and who wanted information from me as to rust-resistant varieties, I learned that wheat of good or first-rate quality can be grown there, and that there appears to be a large area suitable for wheat-growing in that country. A sample of British East African wheat given me had the appearance of well-grown Australian wheat. With this information in my possession, I made further enquiries of the Secretary of State for the Colonies, and he very kindly and promptly sent me the following extract from a "Report by the Director of Agriculture East Africa Protectorate," dated August 22nd, 1908:—

"Wheat is another crop which from results obtained points to profitable extension. The Gluyas wheat imported two years ago has been grown in many districts of the Protectorate, and so far has proved rust-resistant both when sown in the long as well as the short rainy seasons, and samples have been reported upon as possessing very high milling qualities.

"Other varieties, such as Medeah, Jordons Korn, &c., imported from the south, have also given satisfactory results in certain districts, but these require further trial before full dependence can be placed on them.

"Apart from a good and growing local market, there is a market in the south for very large quantities of wheat, and the Proctectorate farmer should, owing to his being able to grow two crops a year, stand on very favourable terms with the farmers of the other wheat-producing countries, where they have to be satisfied with only one harvest a year.

"Arrangements are being make to import from South Australia, after this harvest season, a quantity of fresh Gluyas seed, for issue, and co-operative experiments will be conducted with other varieties to test their comparative merits."

The Rust Problem.

Of all the diseases to which the wheat plant is susceptible, rust is by far the most important. It seems to be ubiquitous. We have seen that it is the chief obstacle to wheat-growing in South Africa, and that in India its ravages have been estimated to cost that country in diminished income £2,000,000 sterling per annum. In Australia conferences were held in the early nineties specifically to consider what could be

done to stay its ravages. In Canada special attention is given to the problem at the experimental farms, and the world has been searched for rust-resisting varieties. In the United States reports of special harm from rust are quite enough to raise prices. It has been said on high authority "that Prussia alone lost some £20,000,000 in one year" through rust. All of our English varieties of wheat are susceptible to it, but fortunately of the various sorts of rust, our wheat fields suffer almost exclusively from yellow rust (*Puccinia glumarum*), which is not nearly as virulent as, say, black rust (*Puccinia graminis*), but there is hardly an English wheat field free from attack in greater or less degree. If any person wishes to obtain an admirable summary of the position concerning rust he should read Professor Biffen's article on "Rust in Wheat" in the "Journal of the Board of Agriculture" for July, 1908. For present purposes I may describe it as a fungoid, parasitical disease, which saps the vitality of the plant, hinders its breathing, and weakens the straw, so that it cannot stand up so well as it ought to do. The only practical remedy for it is to find varieties which are either immune to its attacks or susceptible to only a moderate extent. Each country, or, in the case of large countries, each district, has to work out its own salvation in this matter, for a variety of wheat which is immune to one variety of rust may be susceptible to another, and local conditions have to be taken into account. For instance "Einkorn," a primitive type of wheat, useless as a cropper to an English farmer, has been found to be immune to rust in England, but in certain districts of India it will not yield grain at all. I was lucky enough to find growing among some hundreds of varieties of foreign wheat tested for the Home-grown Wheat Committee at Addlestone, Surrey, a club-headed sort which also is immune to rust in England. Investigators all over the world are similarly searching for immune wheats, and if they find what they want their rust problem is practically solved, for the following reasons.

Farrer had noticed that among the progeny of a cross in which the parents differed as to the extent of their rust resistance, some of the progeny inherited the rust-resisting characteristics of the healthier parent. Professor Biffen, of Cambridge, the botanist member of the Home-grown Wheat Committee, in his application of Mendelian principles to wheat, has gone a good deal further than that, and shown that immunity and susceptibility to disease is a true Mendelian unit which is handed down to the progeny, in a definite ratio, so that a breeder working with two parents, one susceptible the other immune, can predicate with certainty that in the second generation a form or forms, equalling one-quarter of the entire progeny, will be as rust-resistant or immune as the rust-resistant or immune parent is.

In the light of this and similar discoveries, we have no longer to regard a wheat plant from the breeder's point of view as an entity, but as a bundle of entities, each entity susceptible to handling by the breeder and capable of forming a fresh combination with each and every unit in the parents used. The calculation of possible combinations is work for a mathematician when the parents differ on many Mendelian points; in its results it reminds one of change ringing on church bells. I cannot to-day elaborate this point. It opens up and puts on to a scientific basis almost limitless possibilities in the production of new varieties of wheat, each ideal for specified countries or districts, enabling the breeder to take from any variety its one or more good points, apart from which it may be useless, and set it or them up in fresh combinations with other units taken from one or more other varieties. In this way we can get in England maximum quality of grain and straw without sacrifice of cropping capacity, but as a contribution to the world's welfare, nothing we have accomplished can compare with Professor Biffen's work in connection with the rust problem. Nor is its importance limited to wheat or plants. The laws of heredity, on which it is based, apply to plants generally, to animals, and to man, and it may be we are as yet recognising only dimly the possibilities arising from his work on the inheritance of disease in wheat. For present purposes I need only point out that the application of his discoveries may very greatly increase the wheat-production of the British Empire and of the world. It will decrease the uncertainties concerning yield per acre in all wheat-growing countries; it may increase enormously the area on which wheat can be profitably grown.

Effect of Price on Production.

I want to close this paper with a few remarks on the effect of price on production. I have throughout been talking of 30s. c.i.f. per quarter delivered to London. In the last few years good wheats have been realising more than

that, but in the middle nineties their c.i.f. value was about 25s., and having regard to the facts that even now wheat can be grown at a profit at 30s. c.i.f. delivered to London, and that science is showing the producer how to improve the profits of that operation, having regard also to the fact that the quantity of available land on which such wheat-growing can be extended is not nearly exhausted, I do not anticipate for many years to come an average value of wheat, under normal circumstances, in excess or substantially in excess of 30s. The effect of production on price is prompt in its action; the effect of price on production is much slower.

The international grain market may be called a pool, into which the exporting countries pour their surplus, and from which the importing countries draw their imports. Like other great trades the work of the corn trade is highly specialised, and competition very fierce. Variations in quality, weights, methods of packing and transport, the helps and hindrances at each port importing wheat to the quick unloading of ships, and many other points are all known and appraised at a proper price in making bargains. The margins of profit on large transactions in wheat are so exceedingly small per quarter, that there is absolutely no room for sentiment, and, in fact, there is none. Subject to all the variations on technical points and intrinsic worth, all the wheats in good supply are equal in value in the international pool, whatever their origin, and it is true, as a generalisation, to say that the average value of wheat for any year depends exclusively on supply and demand, realised and prospective. Speculators whose operations ignore that primary consideration have their day, and cease to be. Three halfpence per quarter are sufficient to decide the destination of any wheat from the pool, and if any country or port chooses to impose any tax or due on wheat, it is the buyer who pays it, apart from and beyond the price he paid for the wheat in the international pool.

It is, therefore, the value of wheat on this international basis, less the cost of getting it into the pool, which decides what the grower in an exporting country gets; and the international value, plus the added charges, settles the value of wheat in the importing country. If a country can avoid dealings in the international market, and maintains a duty on wheat, its wheat markets follow an independent course, at a higher—perhaps only a slightly higher—level of prices than that of the international pool, but so long as it depends for the sale or purchase of a substantial part of its wheat on international trading, the effects I have indicated follow. At present each country of the British Empire which has a surplus to get rid of, or needs to supply by oversea imports, goes as a separate unit to the international grain market. If an Imperial system of preferential treatment in fiscal matters be set up, the Empire would be one unit in the international market, and until it is self-supporting, the exporting parts of it would realise an advantage in price at the expense of the importing parts of it. If in course of time the Empire, as France has now done for some years, should rather more than balance its production and requirements, growers will lose some of the advantage and consumers be saved some of the cost of the preference set up by law. If, taking a very long view, the Empire produces more than it wants and has to sell a surplus, either the whole advantage of the preference will be lost to the grower in the British Empire, or foreigners will buy the surplus at a lower cost than our own consumers pay for their actual requirements.

For present purposes we have to dissociate scarcity or plenty arising from natural fluctuations in the yield per acre, from scarcity or plenty arising from variations in the acreage planted. We know that the requirements of the United Kingdom are increasing. We have seen that the proportion of our imports supplied by the Empire itself varies very much, and that the highest proportion on an average of years has been 34½ per cent. We have seen that even if all the wheats shipped from Australia, Canada, and India were taken by the British Empire, it would still be a very long way from being self-sustaining so far as wheat is concerned. For many years to come, therefore, the Colonial or Indian seller can, in my view, if an Imperial preference be given, rely on getting an extra price over and above the value of wheat in the international pool, equal to the amount of the Imperial preference, but equally certain am I that the consumer of bread (at any rate, in the United Kingdom) will have to pay it, for merchants, millers, and bakers are working on such desperately fine margins per quarter per sack and per loaf that it is impossible for any or all of those traders to carry the added burden.

Let us see, then, what advantages a small duty, say, 2s. per quarter, will be to the pro-

ducer. On that point we have to bear in mind the extraordinarily low yields of wheat per acre which I have pointed out. The English wheat grower would gain 8s. per acre, the Australian, say, 2s. 4d. per acre, the Canadian 4s. 6d., the Indian 2s. 10d. A person looking casually at these figures may well wonder whether such small additions can have any effect on the area under wheat, but we have to recollect also, the extraordinarily small margins of profit which appear to satisfy the Colonial and Indian producers. Taking that into account, the effect may be greater in Australia than in England, and it does seem to me that this 2s. per quarter may increase the acreage under wheat in the British Empire if the grower really gets an increased price thereby. I have stated it that way, for we have to consider the effect on the price of wheat in the international pool. The foreigner will go on putting his wheat into this pool and selling it at its international value. That value will be the result of demand as well as supply. Only as our purchases from the international pool fall off will the price be affected by any preference which we set up, and until we can be independent of the pool, the price within the Empire will be the price of the pool plus the duty. So if the world's wheat crop, through increased production in the British Empire, gets beyond requirements, the international value of wheat will fall, and with it the value of his wheat to the British Empire producer. It seems to me, therefore, that all the time whilst the British Empire is increasing its wheat production until it becomes self-supporting, the consumer will pay the duty, the British Empire producer will get a pull of 2s. per quarter over the foreigner, but it does not follow that the British Empire producer will be better off. The foreign producer may be worse off, but that is not the same thing as saying he will pay the duty for us, for if a reduction in price be brought about, the benefit of it will accrue to the foreign buyer of imported wheat, as well as to the British importer, and the United Kingdom takes only about half of the wheat exported overseas. Furthermore, it must be remembered that the foreign grower is working on the same small yields, and extraordinarily small margins per acre, and he is not compelled to go on growing wheat. If he does not divert wheat land to other purposes, he may and probably would imitate the Australian and Canadian, who have found it more profitable to fallow the land frequently. The result of extended fallowing has been a smaller production of wheat from the same land in a given number of years, but larger yields per acre in the seasons when the expenses of seed, cultivations, &c., were incurred, which means smaller aggregate production, but increased profits per annum. These problems of wheat production are, like almost all modern commercial problems, extremely complex. It is difficult or impossible to foretell what will happen under normal circumstances. It seems to me absolutely impossible to foretell with certainty what will happen, if, with the best intentions, we still further complicate the problems by interfering, through legislative enactment, with the ordinary course of trade development. We have seen that the wheat-growers of the British Empire and their scientific advisers are well in the forefront of modern developments, that modern scientific discoveries will probably widen the area of production, and in all probability diminish the cost of production if such developments follow a normal course without any artificial raising of prices. The colonial producers, so long as they maintain or improve the actual and relative superiority of their wheats, can always find a market for whatever they produce.

Here the argument must stop. I am not a politician, nor is this a political meeting. I have considered it part of my duty to lay before you some facts concerning the effects of price on production, and I have taken definite proposals as to a preferential duty as an illustration of my argument. I need hardly add that if through the usual workings of supply and demand, the relative abundance of gold, or in any other way, a higher range of prices can be relied upon, an incentive to increased wheat-production will be provided, to which the Empire would respond within a very few seasons.

APPENDIX.

TABLE I.—GREAT BRITAIN: Increase or Decrease in the Average Acreages of Various Crops, Bare Fallow, and Grass, in the Five Years, 1903 to 1907, as Compared with the Average Acreages in the Five Years, 1878 to 1882. (Extracted from Agricultural Statistics for 1907, Vol. xlii., Part I., pages 78 and 79.)

	Increase. 000 omitted.	Decrease. 000 omitted.
Wheat	—	1,339
Barley	—	685
Oats	345	—
Beans	—	168
Peas	—	81
Potatoes	28	—
Turnips and swedes	—	437
Mangold	70	—
Cabbage, kohlrabi, and rape	22	—
Clover and rotation grasses	148	—
Other crops, including small fruit	—	53
Bare fallow	—	407
Permanent grass	2,757	—
	3,370	3,170
Total arable land	—	2,557
Total acreage under crops and grass	200	—

TABLE II.—IMPORTS (in cwts.) OF WHEAT AND FLOUR INTO THE U.K. (Flour taken at the equivalent weight of wheat. Extracted from Agricultural Statistics.)

Year.	Australia.	New Zealand.	India.	Canada.	Total from British Possessions.	Per cent. of total imports from British Possessions.	Total from all sources.
1893	1,790,048	841,283	6,199,985	4,658,681	13,491,340	14½	93,806,666
1894	3,724,847	237,510	5,363,749	4,448,822	13,817,881	14¼	96,702,072
1895	3,574,461	13,700	8,803,228	5,099,183	17,491,309	16¼	107,261,636
1896	6,500	—	2,113,218	6,300,428	8,421,951	8½	99,637,369
1897	—	—	574,579	6,946,459	7,532,415	8½	88,685,553
Average ..	1,819,171	218,498	4,610,952	5,498,715	12,150,979	12½	97,218,659
1898	219,876	4,800	9,538,067	7,745,641	17,509,777	18½	94,418,359
1899	3,028,638	707,128	8,192,339	8,727,222	20,661,452	21	98,505,117
1900	2,919,267	1,138,544	6,239	7,997,627	12,121,757	12¼	98,597,450
1901	6,197,019	1,383,239	3,341,500	8,577,960	19,500,829	19¼	101,064,682
1902	4,217,013	156,643	8,842,182	12,226,382	25,443,851	23½	107,927,701
Average ..	3,316,363	678,071	5,984,065	9,054,966	19,047,533	19	100,102,662
1903	61	204	17,058,698	14,465,484	31,559,499	27	116,744,152
1904	11,364,669	367,294	25,521,097	9,036,643	46,364,147	39	118,230,961
1905	11,480,672	346,706	22,866,311	8,369,391	43,065,472	37¾	114,226,590
1906	8,535,517	79,400	12,638,561	13,824,283	35,077,861	32	112,675,950
1907	8,506,700	3,300	18,280,989	15,022,366	41,850,111	36¼	115,636,564
Average —	7,977,524	159,381	19,273,151	12,143,633	39,583,418	34½	115,502,843
1908*	5,820,600	—	2,948,900	16,810,984	25,586,784	23½	109,147,808

* Ascertained from "Beerbohm's Evening Corn Trade List" since Table was compiled.

TABLE III.—AREAS UNDER WHEAT IN AUSTRALIA IN THOUSANDS OF ACRES (from the Commonwealth Year-Book for 1908).

Season.	New South Wales.	Victoria.	Queensland.	South Australia.	Western Australia.	Tasmania.	Commonwealth.	Population.
1880–1	253	977	13	1,734	28	50	3,054	2,231,531
1885-6	265	1,020	10	1,923	39	30	3,277	2,694,518
1890–1	333	1,145	10	1,674	34	32	3,229	3,151,355
1895–6	597	1,413	27	1,650	23	65	3,774	3,491,621
1900-1	1,531	2,017	79	1,913	74	52	5,667	3,765,339
1901–2	1,392	1,754	87	1,743	95	44	5,116	3,826,286
1902–3	1,280	1,994	2	1,747	92	41	5,156	3,883,079
1903–4	1,561	1,969	138	1,711	138	49	5,566	3,926,969
1904–5	1,776	2,278	151	1,840	182	43	6,270	3,984,390
1905–6	1,939	2,071	119	1,757	195	41	6,123	4,052,430
1906-7	1,866	2,032	115	1,682	250	33	5,978	4,119,481

TABLE IV.—AUSTRALIA: PRODUCTION, EXPORTS AND IMPORTS (IN THOUSANDS OF BUSHELS) OF WHEAT. (Flour taken as the equivalent quantity of wheat.)

Season.	New South Wales.	Victoria.	Queensland.	South Australia.	Western Australia.	Tasmania.	Commonwealth.	Net Imports of Wheat and Flour.	Net Exports of Wheat and Flour.
1890–1	3,649	12,751	208	9,399	467	643	27,118	—	8,649
1895–6	5,195	5,669	124	5,929	188	1,165	18,270	3,093	—
1900–1	16,174	17,847	1,194	11,253	775	1,110	48,353	—	24,775
1901–2	14,809	12,127	1,692	8,013	957	964	38,562	—	9,929
1902-3	1,585	2,569	6	6,355	986	877	12,378	10,675	—
1903–4	27,334	28,526	2,437	13,209	1,876	767	74,150	—	38,535
1904–5	16,464	21,092	2,150	12,023	2,013	793	54,536	—	32,308
1905–6	20,737	23,418	1,137	20,144	2,308	776	68,521	—	38,562
1906–7	21,818	22,618	1,109	17,146	2,759	651	66,101	—	34,440
1907–8	9,200	12,800	480	19,200	2,720	800	45,200	—	18,200
*1908–9	15,600	28,000	1,600	20,800	3,500	800	70,300	—	(current year)

* Partly estimated.

Figures for 1907–8 and 1908–9, and those for the exports of 1906–7, supplied by Mr. J. W. Rush, Editor of "Beerbohm."

TABLE V.—YIELD OF WHEAT PER ACRE IN BUSHELS, 1901–2 TO 1906-7 (Taken from Commonwealth Year-Book for 1908.)

Season.	New South Wales.	Victoria.	Queensland.	South Australia.	Western Australia.	Tasmania.	Commonwealth.
1901–2	10·64	6·91	19·40	4·60	10·10	21·86	7·54
1902–3	1·24	1·29	3·28	3·64	10·67	21·44	2·40
1903–4	17·51	14·49	17·65	7·72	13·60	15·53	13·32
1904–5	9·27	9·26	14·24	6·53	11·06	18·40	8·70
1905–6	10·69	11·31	9·53	11·46	11·83	18·79	11·19
1906–7	11·69	11·13	9·68	10·19	11·02	19·86	11·06
Average ..	10·17	9·06	12·30	7·36	11·38	19·31	9·03

TABLE VI.—CANADA: SOME PARTICULARS CONCERNING THE PRODUCTION AND EXPORT OF WHEAT. (Furnished by Blue Books, and Mr. G. J. S. Broomhall, Editor of *Corn Trade News* and the "Corn Trade Year Book.")

Year.	Acreage under wheat in the Provinces of Manitoba, Saskatchewan and Alberta.	Yield per acre in the N.W.	Production of wheat in the North-West.	Total Canadian Production.	Exports of wheat and flour, stated in quarters of wheat. Fiscal years.	Population.
		bushels.	quarters.	quarters.		
Average per annum for 5 years 1894 to 1898 inclusive.	—	—	—	6,323,500	1,598,600	4,833,239 (1891)
1899	1,993,518	17·53	4,354,732	7,300,000	1,752,000	
1900	1,870,260	9·11	2,131,693	5,500,000	2,548,000	
1901	2,516,532	25·16	7,913,810	10,600,000	1,863,000	5,371,315
1902	2,665,698	25·14	8,379,265	11,700,000	3,899,000	
1903	3,280,107	17·14	7,028,556	9,800,000	4,848,000	
Average	2,465,223	18·82	5,961,611	8,980,000	2,982,000	
1904	3,334,667	17·19	7,004,750	8,600,000	2,990,000	
1905	3,881,199	21·70	10,521,900	13,400,000	2,581,000	
1906	5,049,250	20·25	12,782,000	14,000,000	5,912,000	
1907	5,010,352	14·00	8,750,000	11,000,000	3,800,000*	6,504,900
1908	5,700,000	16·00	11,375,000	14,000,000	6,446,000	(estmd.)
	4,595,094	17·83	10,086,730	12,200,000	4,574,527	

* For 9 months owing to change of Canadian fiscal year, which used to end on June 30, now on March 31.

TABLE VII.—INDIA: SOME PARTICULARS CONCERNING THE PRODUCTION AND EXPORT OF WHEAT (000 omitted in each column except as to yield per acre).

Fiscal Year to March 31.	Acreage in Punjab and N.W. Frontier Province.	Acreage in United Provinces.	Acreage in Central Provinces.	Total acreage in India.	Total crop of India.	Yield per acre.	Exports of Wheat.	Exports of Flour.	Total exports Wheat and Flour. Flour = 66·66 p. c. of wheat.
					tons.	bushels.	cwts.	cwts.	cwts.
1894	8,265	6,675	3,986	28,717	7,269	—	12,157	611	13,073
1895	8,052	6,334	3,393	28,422	6,999	—	6,904	588	7,786
1896	6,893	5,177	2,714	24,071	5,380	—	10,003	662	10,996
1897	6,584	3,932	1,970	20,580	5,363	—	1,911	600	2,811
1898	8,014	5,985	2,172	24,538	7,208	—	2,393	505	3,150
Average	7,562	5,621	2,847	25,266	6,444	9·52	6,674	593	7,563
1899	7,729	6,349	2,505	25,370	6,838	—	19,524	683	20,549
1900	6,366	6,203	1,633	18,688	5,357	—	9,704	558	10,541
1901	8,766	6,790	2,056	23,865	7,094	—	50	497	796
1902	8,024	6,462	2,620	23,446	6,091	—	7,322	529	8,115
1903	7,818	6,910	2,285	23,395	7,971	—	10,292	718	11,369
Average	7,741	6,543	2,220	22,953	6,670	10·85	9,378	597	10,274
1904	8,760	7,789	2,921	28,414	9,641	—	25,911	810	27,126
1905	8,594	7,706	3,068	28,470	7,582	—	43,001	1,031	44,548
1906	9,597	6,479	3,020	26,357	8,579	—	18,750	899	20,099
1907	10,208	7,039	3,272	29,489	8,448	—	16,029	818	17,256
1908	8,149	4,409	2,471	20,963	5,704	—	17,609	(est) 850	18,884
Average	9,062	6,684	2,950	26,739	7,991	11·16	24,260	882	25,583

DISCUSSION.

The CHAIRMAN (Earl Carrington, K.G., G.C.M.G.), in opening the discussion, said the last part of the interesting paper which had been read reminded him of the fact that over 100 years ago, when his grandfather was President of the Board of Agriculture, he made a speech in which he said that one of the most important subjects the Board had to consider was the scarcity of wheat. He also remembered his father, who was born 103 years ago, telling him that in the early part of the nineteenth century they did not have white bread at every meal at his father's table, because it was so scarce. If such a thing happened at the table of old Robert Smith, the banker, in Whitehall, he (Earl Carrington) left the audience to imagine what sort of stuff the bread must have been that the unfortunate working classes were compelled to eat in those days. It was a coincidence that a century later the question of the sufficiency of our wheat supply should be again under consideration. He did not say for a moment that there would ever be a scarcity of wheat; from what the author said there seemed to be no doubt that there would always be an abundance of wheat, but would it always be cheap wheat? The price was the problem, and the important point to discuss was whether they could continue to supply cheap bread, and, if so, for how long. Some thought that cheapness of food was simply a question of new railways and improved steamships, but he ventured to think that those alone would not be sufficient. Not only must new areas be developed, but he agreed with the author, that the production of existing areas, including the wheat-growing land of Great Britain itself, must be increased. It was well known that England grew a good deal less wheat than was the case thirty years ago, partly owing to the cost of production, and the lowness of price, and partly because of the falling off in the quality of the wheat grown in this country. The change had been very gradual, and growers, to some extent, were not aware of it; but when they awoke to the fact they said the real reason was the climate, and that it could not be helped. Mr. Humphries was not satisfied with that reason, and asserted that the deterioration in English wheat was largely an accident, implying that farmers grew the wrong sort of wheat, wheat of a poor quality, chiefly because it was prolific. But wheat of high quality might also be prolific, and such wheat had already been produced by Professors Biffen and Wood, of Cambridge. He did not desire to blow the trumpet in praise of his own department, but he thought he ought, on the present occasion, to mention the name of Professor Middleton, who had done such good service at the Board of Agriculture. In conclusion, he wished to compliment the author on the sensible, practical, straightforward, and statesmanlike paper he had given, and to thank him for the invaluable service he had done to British agriculture in bringing the subject before the public at large.

Sir JOHN M'DOUGALL, L.C.C., said that twenty years ago he took a great interest in the question of wheat, and had the honour of addressing a meeting of the Society of Arts on the subject, but since then he had been actively engaged with the Chairman in the management of London, and he dared not criticise the paper because his opinion was somewhat out-of-date. He wished, however, to refer to the wheat grown in Egypt, and to ask whether Egypt was a part of the British dominions. In the early days, dirty and rubbishy wheat was received from that country, but within the last few years he had seen samples of white Bombay wheat grown in Egypt which were of a magnificent description. He was ignorant as to whether such wheat was on the market, but he thought there were great possibilities for such an article if it were properly gathered and kept free from dirt. Possibly political considerations precluded the author from mentioning the point in his paper. So far as English wheat was concerned, considerable trouble was experienced in the old days owing to the necessity of examining a small sample of a very small bulk, and sending somebody to verify whether the bulk was equal to the sample. The condition was such very frequently that the wheats would not lie together in great bulk; each sample had to be kept at the railway station, goods yard, or dock in small quantities, which occupied a large area and caused a great deal of expense. If anything could be done with a view to minimising the cost of the collecting, sampling, and buying of English wheat, it would be the tendency to raise its price and increase the demand. In America and Canada the wheat was graded, put into bulk, and transported at very cheap rates. There was nothing of more importance to the people of the country than the question of wheat supply.

The Hon. J. W. TAVERNER (Agent-General for Victoria) explained that the apparent falling off or stationary condition of wheat production in Australia was in consequence of the Australian farmer going in for mixed farming, a good deal of land now being used for lamb raising and other purposes, which paid exceedingly well. The last speaker had referred to the vital question of transport, which not only affected the English buyer but the Australian buyer to a very large extent. It was a matter of congratulation to Australians that Parliament had succeeded in passing that very valuable measure, the Port of London Bill, and he trusted that no time would be lost in bringing it into operation, because he had no hesitation in saying that London, which prided itself on being the leading commercial city in the world, was most obsolete so far as her dock conveniences were concerned. That applied not only to wheat but to fruit and to all manner of productions that were imported into the country, and he looked forward to seeing, within a reasonable time, such conveniences in London as were to be found in Germany and other parts of the world. The question of supplying the

Empire troubled the Australians a good deal. They realised that at the present time the Empire did not produce sufficient wheat for the consumption of their own people. Recently a demonstration was given at the Franco-British Exhibition showing the capabilities of bread made from Australian flour, which clearly indicated that the bread produced from such flour was beautifully white in colour, and of a most nourishing description—in fact such bread as the Chairman, during the five years he was an Australian Governor, thrived on. He had also personally been brought up on bread manufactured from wheat grown on soil which was naturally adapted to the production of corn, whereas a great deal of the soil in this country was not naturally adapted for wheat production. He claimed for Australian wheat that it possessed all the qualities necessary for the manufacture of good bread. At the demonstration to which he had referred, the King's baker manufactured the bread, which was pronounced to be excellent, particularly the white, which he was informed by an expert was too good, English people being accustomed to something to "tussle" with. He disagreed with the author's statement that it cost 17s. 6d. per acre for the production of wheat in Australia. If the production of wheat in this country and Australia were compared, it would be found that two very different conditions existed. Australians claimed that their methods of cultivation and harvesting were up-to-date, but in some parts of England single-furrow ploughs, such as Adam used, were still employed. On the other hand, in Australia, four, five, and six-furrow ploughs, drawn by steam engines, were used, which greatly reduced the cost of labour. He thought the cost of producing Australian wheat was something like 11s. to 12s. per acre. It was necessary also to bear in mind the difference between the value of wheat land in this country and Australia. Wheat was grown upon land in the Colonies which was worth 50s. to £3 an acre, against £25 to £35 in this country, so that although the results obtained by the farmer on the cheaper land were less, upon the whole his profits were equally good. He would have great pleasure in forwarding a copy of the paper to the Minister of Agriculture. He desired, in conclusion, to thank Lord Carrington, Lord Crewe; and other Ministers of State, for the great interest they continued to take in all matters appertaining to Australian affairs, thus endeavouring to bring about that good feeling which should exist between the Motherland and the Colonies. A good deal was now heard about the safety of the Empire and the merits of the army and navy, but he thought the country could rest assured that, so long as the army and navy were fed upon good Australian bread, they were perfectly safe.

Major P. G. Craigie, C.B., thought it was impossible to criticise from a purely statistical point of view without closer study the mass of figures that had been placed before the audience, but the Society was to be congratulated on obtaining such a luminous array of considerations that had to be borne in mind from the political, economic, and productive point of view in discussing the wheat supply. He had been particularly struck by the author's remarks on the development which might be expected in the quality of the wheat grown. He felt inclined to follow Sir John M'Dougall in suggesting that the last had not been heard of Egypt as a possible source of wheat supply under the extensions which were now being made. He would like, however, to say one word of caution in arriving at conclusions of the general character which the audience were asked to assume from the paper. The enormous variety of the range of yield in the countries concerned, and the widely varying consumption per head of wheat together with other grain, were factors which interfered with all calculations. He had on one or two occasions, taking the English agricultural returns, endeavoured to contract what was known of the wheat production of the world, and it was surprising how much of it was in the hands of three great Empires. Out of 219,000,000 acres under wheat cultivation, 140,000,000 belonged to the United States, Russia, and Britain. It was not often remembered that the British Empire stood third in rank as a wheat-producing Empire. But the wheat raised on that acreage represented all ranges of yield, from 5, 6, 7 and 8 bushels on some of the arid land, to the 32 or 34 bushels, which was the average in this country. One other factor which also had to be borne in mind when contrasting the condition of this country with European nations, and which was sometimes left out of sight in calculation on the question of price, was the rye crop. The Russian Empire and Germany between them accounted for nearly 90 per cent. of the rye grown in the world, Russia being responsible for 75 per cent. and Germany 15 per cent.; and he thought those facts might be usefully considered with the figures which had been given in the author's excellent paper.

Mr. A. E. Humphries, in reply, thought the Chairman had hit the nail exactly on the head so far as the question of English wheat was concerned. It was true that, for a long time, people thought the English climate was a fatal hindrance to the production of wheat of high quality. It had now been proved that it was not a question of climate, but the provision of a variety or varieties of wheat particularly suitable to the environment in which it was grown. The world had had to be searched for samples of wheat; many hundreds of those samples had been grown, and it had been found that only a very small percentage of them answered requirements. Only 2 or 3 per cent. of the samples tried would maintain in England their high quality, and of those 2 or 3 per cent., the one outstanding variety was Fife wheat, which was known in England as the Canadian type, but which, in point of fact, was a European variety imported into Canada,

by accident, sixty years ago. Professor Biffen's discoveries had enabled them to take from the Fife wheat the high quality, and by hybridizing and selection transfer it into any kind of wheat which thrived in England. That was in process of being carried out. They were not yet in a position to put such wheats forward to the world in commercial quantities, but he had no doubt whatever that the finish of the matter would be that, so far as Fife wheat was concerned, there were many places up and down the country where it was worth growing as a commercial proposition on its own account — not grown to please the miller, but simply to give a satisfactory return to the farmer. Millers had this year begun to realise what its real intrinsic worth was, and had been paying as much as 2s., 3s., and 4s. a quarter premium for Fife wheat grown in England for the sixth year in succession over and above the value of ordinary English wheat. The extreme importance of Professor Biffen's discoveries had not yet, he thought, been sufficiently realised. The principal point to which he wished to direct attention was that it was not a question of climate or of soil as such; the real crux of the whole matter was to find a fitting environment for any good variety, or to provide any given set of natural conditions, with a variety or varieties suitable to it. He entirely left out the question of Egypt and the Soudan, which had been referred to by Sir John M'Dougall, for two reasons, the first being that he did not want to introduce foreign complications by suggesting that Egypt was in the British Empire. Secondly, as a matter of fact he had in his possession at the present moment samples of wheat sent over to him by the Soudan Government, which he was now testing and reporting upon, because there was something in the wind with regard to that country. Some of the samples were good, but for some reason best known to themselves the Soudan authorities did not desire him to talk about the matter. He had already begun to do so, and he hoped they would forgive him. Mr. Taverner had referred to the London Docks as being obsolete. If he meant by that observation that they were obsolete in their grain-handling appliances, he was absolutely wrong, because there was no port in the world, he believed, that could discharge a cargo of wheat so rapidly and so efficiently as the Port of London. That was not the trouble of which complaint was made. Where they found fault with the administration of the docks was that receivers were now being charged exactly the same for discharging wheat as was the case forty years ago when it was done by hand. The docks had kept themselves up-to-date by introducing modern machinery which worked efficiently, but the traders were being charged for handling bulk wheat in London something in excess of three times what it cost. In other words, one of the first duties of the new dock authority was to take care that those people who had been getting their goods into London on the cheap should have a proper charge put upon them, and that the charges as between the whole of the traders should be equalised. It was absolutely necessary to ascertain definitely upon a proper basis the cost of handling, and base the charges upon that item, plus a profit. If that were done, the cost of handling bulk wheat would come down most materially. But it must not go forward that London was in any degree obsolete in her appliances for handling wheat. He quite agreed with Mr. Taverner's remark that Australian wheat was very good, the only trouble being that not enough of it was obtained in this country. The quality of average London bread, or the bread of the United Kingdom, could not be raised by Australian wheat to any appreciable extent, because unfortunately the imports of Australian wheat were only about 6 per cent. of the total quantity that came into the country, so that it was impossible to show in the average loaf the advantages of Australian wheat. What Mr. Taverner had said with regard to the cost of production was hardly a criticism of his remarks. The authority for the statement made in the paper, that the cost of handling on large farms, with first-class appliances, was 15s. 6d. per acre, was the Agent-General for New South Wales. But whether it was 15s. 6d. or 11s. 6d. did not for present purposes, in his opinion, matter much; both figures were extraordinarily low, and showed that the Australian farmer was a practical man, who was able to get a profit out of an incredibly small return. In conclusion, he desired to express his thanks to the following gentlemen for the help they had given him with regard to the information contained in the paper: The Secretaries of State for India and the Colonies; the High Commissioners for Canada and New Zealand; the Agents-General for New South Wales, Victoria, South Australia, Queensland, Tasmania, West Australia, Cape of Good Hope, Natal, and Orange River Colony; the Transvaal Department of Agriculture; the British South Africa Company; the Economic Botanist of the Imperial Research Institute, Pusa, Bengal; the Editors of "Beerbohm's Evening Corn Trade List," and "The Corn Trade News;" and last, but very far from least, Professor Biffen. He also wished to acknowledge, as the best compliment they could have paid him, the attendance of numerous gentlemen from Mark-lane, merchants and millers. Bearing in mind the usual fate of a prophet in his own country the mere fact of their coming was one he very greatly appreciated.

On the motion of the CHAIRMAN, a hearty vote of thanks to Mr. Humphries for his valuable paper was carried.

Sir WESTBY PERCEVAL, K.C.M.G., in thanking Earl Carrington for presiding, assured his Lordship that the Committee of the Colonial Section of the Society, of which he (the speaker) was Chairman, considered it a great honour to have had his

Lordship's presence with them that afternoon. By attending the meeting Lord Carrington had added one more earnest to many he had already given of the interest he took in everything that appertained to the important Department over which he so capably presided. He also wished to announce that the paper which had been read was one of a series which would be read in the Colonial Section, the next paper being on Wool. It appeared to the Council that the staple products of the Empire were subjects which were not only interesting, but would, they hoped, prove instructive. He personally thanked the author for his paper.

NINTH ORDINARY MEETING.

Wednesday, February 10, 1909; COLONEL SIR COLIN CAMPBELL SCOTT-MONCRIEFF, K.C.S.I., K.C.M.G., Member of the Council of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Cole, George William, A.M.I.E.E., The Kanan Devan Hills Produce Company, Munnar P.O., S. India.

De Worms, Baron Percy George, F.R.S.L., 21, Lowndes-street, S.W.

Maclaren, William Frederick de Bois, The Rubber Estate Agency, Mincing-lane-House, Eastcheap, E.C.

O'Hagan, Lady Alice M., Pyrgo-park, Havering-atte-Bower, Essex,

Rimell, George J., 53, Shaftesbury-avenue, W.

Wilson, Frederic Frank Munro, Brentmead, Barnfield-road, Ealing, W.

Yeoh Paik Keat, Messrs. Tiang Lee and Co., Kuala Lumpur, Federated Malay States.

The following candidates were balloted for and duly elected members of the Society:—

Bauer, Charles, 72 and 74, Cannon-street, E.C.

Fensler, August, 9, Great Tower-street, E.C.

Hatch, John Newbery, Messrs. Hatch, Carter and Co., Tientsin, North China.

Hawksley, Charles W., 115, Fellows-road, N.W.

Jones, Arthur Edward, Assoc.M.Inst.C.E., Public Works Department, Eastern Bengal and Assam, Dacca, India.

Khoo Sian Tan, Chop "Khoo Chin Hong," Cecil-street, Singapore, Straits Settlement.

Piercy, Rev. William Coleman, M.A., 30, Markham-square, S.W.

Rider, Frank P., 181, Union-street, Southwark, S.W.

Robertson, Alexander Winton, Glencaise, Chalkwell-avenue, Westcliff-on-Sea, and Engine Works, Royal Albert Dry Docks, E.

Seeck, M., 6, Henrietta-street, Covent-garden, W.C.

Tonkin, Alfred James, 156, Strand, W.C.

Vernon, William Allen, Bohun-lodge, East Barnet, Herts.

The CHAIRMAN, in introducing the reader of the paper, said that he made Mr. Colquhoun's acquaintance nearly eighteen years ago when they were colleagues together in the Public Works Department of Burma. Mr. Colquhoun went home on furlough, and in due course, instead of returning to Burma by the orthodox mail steamer across the Bay of Bengal, he reappeared in Upper Burma from China, having made a remarkable journey across the whole width of China. Finding a Government department not sufficient to satisfy his enterprise, Mr. Colquhoun had devoted himself to travelling, and had the traveller's knack of finding himself at places which were centres of interest. He had travelled through Mashonaland, Rhodesia, Siberia, Mongolia, the Islands of the Eastern Archipelago, Borneo, and the Philippines, and he had also paid a visit to the Panama Canal.

The paper read was—

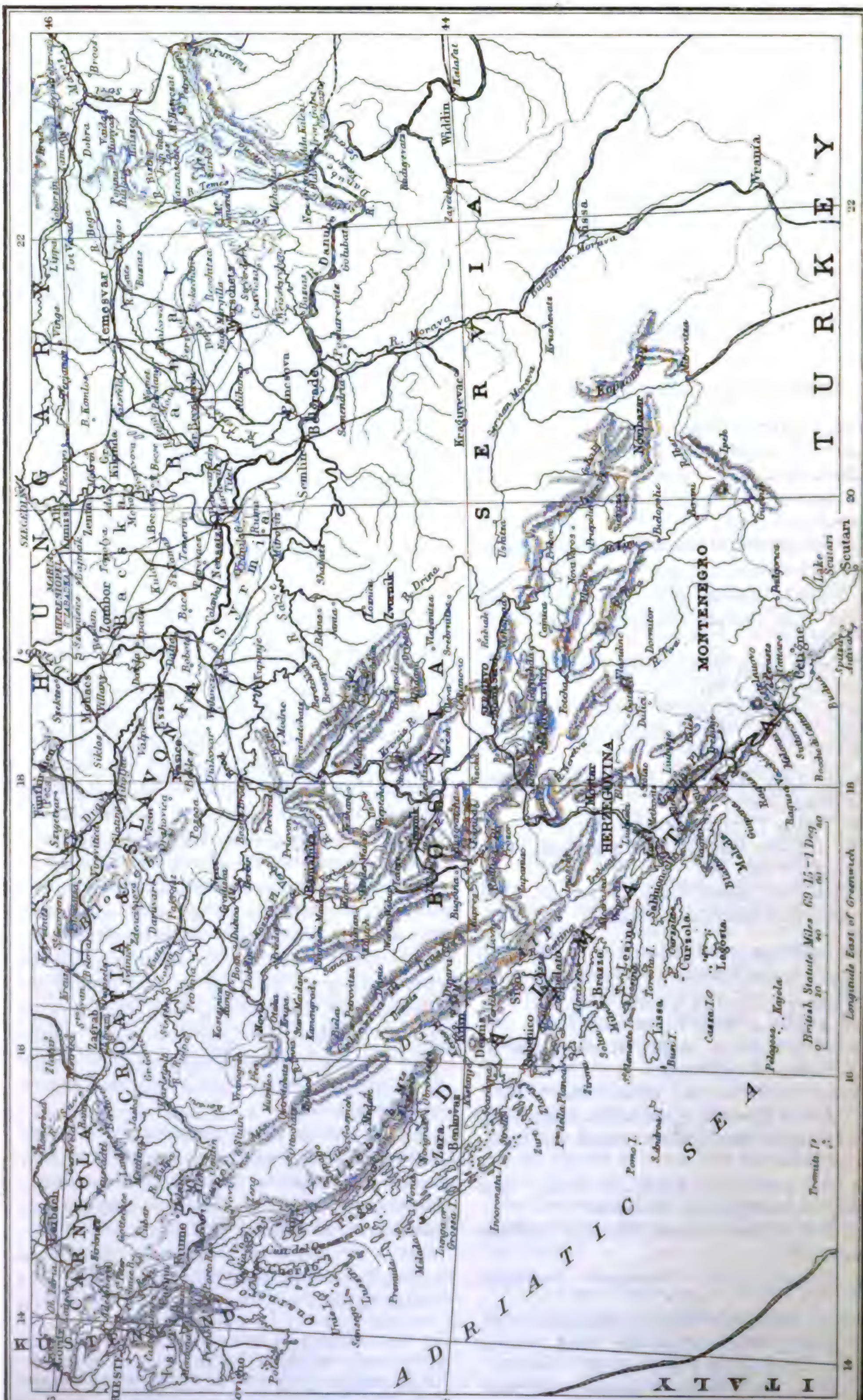
BOSNIA-HERZEGOVINA.

By ARCHIBALD R. COLQUHOUN, F.R.G.S.

A great deal of public attention has been directed lately towards that corner of the Balkan peninsula which is known as Bosnia-Herzegovina. Austria-Hungary has declared that she intends this region to be incorporated permanently within her own dominions, instead of regarding it, as heretofore, as a sort of military protectorate, and the agitation in the Balkan countries generally, caused by this decision, has brought us to the eve of another war in the Near East, whose consequences would inevitably be very far-reaching. Before endeavouring to give you an idea of the two countries, of their people, and the problems involved, I shall show you four maps,* which will make much clearer than words can do the geographical and political position of Bosnia and Herzegovina.

The first map shows the political divisions of the Balkan peninsula and the principal Slav countries—Bulgaria, Dalmatia, Montenegro, Macedonia, Servia, Bosnia - Herzegovina, Slavonia, and Croatia (running up into Carniola)—by which you see that Bosnia is bounded on the north by the river Save (which divides it from Hungary), except on

* The features shown in the four maps projected on the screen, are reproduced in the two maps on pp. 254 and 256. The blocks, from which these are printed, were kindly lent by the Royal Scottish Geographical Society.



THE SLAV COUNTRIES OF THE BALKAN PENINSULA.

the north-western corner, where Bosnia merges imperceptibly into Croatia. There is a thin strip, Dalmatia, between Bosnia-Herzegovina and the Adriatic, cutting them off from the sea altogether. On the east there are Montenegro, the *Sanjak* of Novi-Bazar (still Turkish), and Servia, the boundary between Servia and Bosnia being the deep, narrow, sluggish, green-watered river Drina.

The second map shows that, although rivers have been used as boundaries, the whole of this region is a congeries of mountains—part of the Dinaric Alps which form the watershed between the Adriatic and the Black Sea. On the north sluggish rivers dawdle to the Danube; on the south thin torrents race down to the coast, often losing themselves underground. The Dinaric Alps are not to be compared with the better-known mountains bearing the latter name. The highest peaks, not much more than 8,000 feet, are found in Montenegro, and nowhere is there a region of perpetual snow and glaciers. Approaching Bosnia from the north, from the fat and fertile Hungarian plain, one finds at first English-looking scenery of green pastures and trees at the foot of the mountain slopes, but soon there is a tangle of ever-rising hills such as we are unacquainted with; the scenery very rich, with well-watered valleys and heavily-timbered mountain slopes. On the south of the watershed, however, as we descend to the coast through Herzegovina, the mountains become extraordinarily bleak and barren, and the strata of the limestone formation are plainly visible, showing nakedly on the sides of the mountains, which look as if lines had been ruled on them and then, at times, roughly broken up. In this *karst* region, as it is called, there are said to be "more stones than grass." A great deal of the desolate aspect is attributed to the wanton destruction of the forests by the Venetians for their shipbuilding.

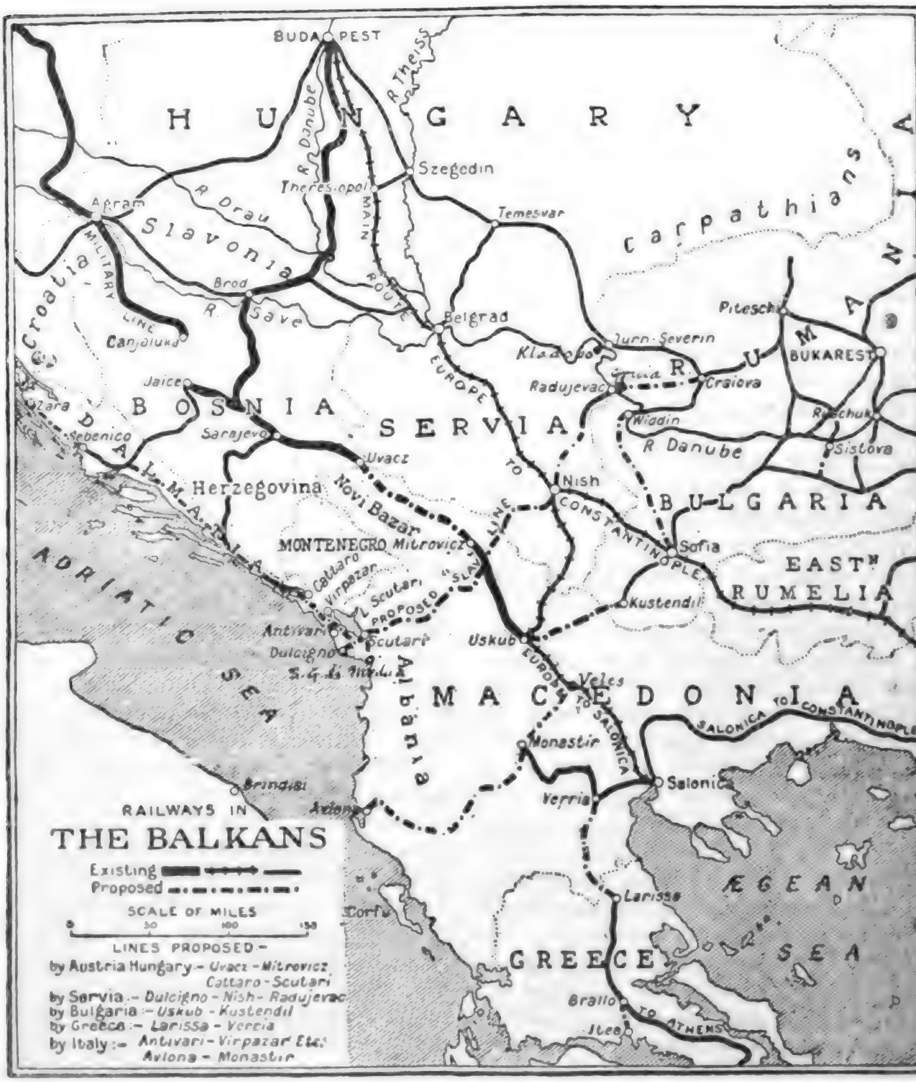
The third map shows the river basins of the Balkan Peninsula, and the drainage towards the Mediterranean and Adriatic, on the one hand, and the Black Sea on the other. You will observe that the lines of the rivers run generally from north-west to south-east, and also that the Danube drains an enormous area. The importance of this great artery cannot be over-estimated; it is a dominating fact in the countries north of the peninsula. There is only one bridge into the Balkan countries over the Danube, namely at Chernavoda, further east than is shown in the map (near the Black Sea, between Roumania and Bulgaria). The bridge at Belgrade is across the Save river, and *not* the Danube.

The fourth map shows the railway lines constructed and proposed. From north to south runs the line by which I travelled to Sarajevo (the capital of Bosnia) and thence southwards. Eastward of Sarajevo is the continuation of this railway, with two branches, to the Turkish and Servian frontiers respectively. This line (opened in 1906) is a triumph of Austrian engineering. It passes through the most wild and romantic scenery, piercing mountain spurs, bridging deep gorges, creeding over hills, and winding through dales. In nine miles it has no less than ninety-nine tunnels and thirty important iron bridges. This is the first instalment of a railway policy long determined on by Austria, to connect the Bosnian system, *viâ* the *Sanjak* of Novi-Bazar, with Mitrovicz, and thus open a new Austro-German highroad to Salonika and the Aegean. And it must be noted that, though Novi-Bazar has been evacuated, the right to construct this railway still remains. As shown on the map, there is only one break —in Bosnia—between the terminus of the military line running south from Agram (the capital of Croatia) and Banjaluka. If this were filled up, a line would give direct communication from Austria and Central Europe to Salonika which would be a powerful competitor to the route *viâ* Budapest and Belgrade. The proposed Slav counter-lines, to which reference is made later on, are clearly shown, as well as the suggested Italian line to connect Monastir (a most important district) with the Adriatic.

And now, asking you to keep these main political and geographical conditions clearly in your minds, let me turn to the countries themselves. Their history, like that of other Balkan States, is one long record of struggle. Evidences remain of prehistoric occupation, in the shape of forts and cromlechs, but it is only in Roman times that we emerge on safe ground. The Romans conquered the country, and in the first century before Christ it became the province of Illyricum. Many traces of Roman times remain—baths, villas, bronzes, pottery, tiles, mosaics, and coins are found in various parts—and a small Roman town has been unearthed, also two interesting relics in the shape of very early Christian basilicas. When the Roman Empire declined Illyria was overrun by tribes—Vandals, Goths, and Slavs. The last came to stay. On the coast Latin civilisation and blood held their own, and the mountains of Albania are said to have also harboured the Roman Illyrians, flying before

the Slav wave, but the greater part of the Balkan peninsula was swallowed up in the Slav irruption, and its population is Slav to this day.

The Slav peoples are differentiated as Russians, Poles, Czechs (Bohemians), Croats, Serbs (Servians), and Bulgars, who, although



Railways in the Balkans.

with a foreign strain, are Slav by their language which is closely allied to that of the Serbo-Croats. There are three great branches of the Slav languages—Russian, Polish-Czech (or Polish-Bohemian), and Serbo-Croat—the last, with slight differences of dialect, being spoken by all the Slavs of the Balkan peninsula, whose States have been shown by me on the map. Now, when the Christian religion came to the Southern Slavs, it was brought both from the eastern and the western Churches, from Byzantium and from Rome, and in Bosnia these forces seemed to have overlapped most. Therefore we find there, side by side, two main branches of the Christian religion—the Orthodox and the Roman Catholic Churches—and two forms of writing—the Latin and the Cyrillic—the latter being that used in Russia and originally adapted from uncial Greek. Nowadays it is usual for children in Bosnia-Herzegovina to learn both alphabets, but it would be considered renegade to one's Church to use the Cyrillic character

for the Christian name if one happens to belong to the Roman Catholic Church, and *vice-versâ*. Needless to say, there has always been considerable rivalry between the Churches, and political friction results, which is increased by the fact that Croatia, Bosnia's western neighbour, is Catholic, while Servia, on the east, is Orthodox. The generic term for Roman Catholics is therefore "Croat," while those belonging to the Greek Orthodox Communion are called "Serb." The two names denote not a racial but a religious difference. The term "Serbo-Croat" is therefore applied to a large portion of the Southern Slavs.

Besides Serbs and Croats, there is a third and very large section of the people who are of Slav descent and yet are strict Mohammedans. Bosnia-Herzegovina, in fact, exhibits the unique spectacle of a country in which one-third of the people, having either been Christianised or offered Christianity, chose to become Mohammedans. The story of their conversion is most strange. About the time that Latin and Byzantine monks were beginning their conversion of the Slav peoples, a strange religion began to spread from east to west across Southern Europe. The nature of this religion is difficult to define accurately, since no writings of its adherents remain, and we have to depend on the evidence of those who denounced it. Apparently it was an Oriental religion not unlike the philosopy of Mencius in China, and also resembling the creed of the Parsees. Its main feature was the belief in the dualism of the principles of good and evil, and in the continual warring of these two forces, both proceeding from a Supreme, Invisible Being. In some respects the devotees of this faith resembled the Manichæans, who were believed to worship devils, and, although their creed seems to have enjoined purity and asceticism of life, they roused the horrified antagonism of Christians and Mohammedans alike and drew down the most relentless persecutions. The name by which they were known is Bogomile, whether from the name of one of their leaders or from some phrase is uncertain. The head and front of their offending undoubtedly lay in their denial of all sacerdotal authority. There was no priesthood among them, and they denounced the worship of images—even the sign of the crucifix—and all ceremonies, including that of baptism by water. They accepted the New Testament story, but denied some of the fundamental doctrines which the Church had built upon it. In many respects, it will be seen, they resembled the Protestants of a later age, and there is no more strange and interesting page in history than the story of this much persecuted sect. The Albigenses were off-shoots of the Bogomiles, and the Swiss Vaudois and the Italian Valdesi are said to be descendants of this sect.

It was the opposition of the Bogomiles to the Roman Catholic religion which caused them to throw in their lot with the Turks in the fifteenth century. At this period Bosnia, which had for a short time been an independent kingdom, was a feudatory of Hungary, and in the struggle between that country and the Turks a Bosnian prince, who was secretly a Bogomile, betrayed his castle and fortress to the Turks. A large number of nobles followed his example, and from them are descended the Bosnian nobles, or *Begs*, who still own a great part of the country, though their power is declining and their incomes are dwindling under the Austrian *régime*. A considerable portion of the peasantry is also Mussulman, and so we have the strange spectacle of people of the same race who belong to two different Christian churches and to Islam, and yet live amicably side by side. The proportions are, roughly, Serbs (Orthodox) 700,000, Mussulmans 600,000, and Roman Catholics 300,000, but the Catholics include all the Austrian officials and their families, the railway servants, the officers, the majority of the Austrian troops of occupation, and a considerable number of Catholic traders. The permanent Catholic native (Slav) population is probably not more than 70,000, while other denominations account for only 12,000. The total population is over one and a half million. Although all the Bogomiles nominally embraced Islam, there is no doubt that the persecuted faith lingered until recent times, and some writers believe that it is still secretly preserved.

Bosnia and Herzegovina were both conquered by the Turks in the fifteenth century. As to the latter, it may be said here that it should be spoken of as *the* Herzegovina, the Emperor having in the fifteenth century given its *voivode* the title of Herzog—hence Herzegovine, or "the Duchy." I shall, however, adopt the less ceremonious form. At one time, prior to the Hungarian conquest, Bosnia was part of the Servian dominions, and it is a complication of the political situation that the Servians, who hope to revive the glories of their ancient kingdom, cast longing eyes upon their lost provinces in Bosnia.

We are, however, unable to follow here the tangled, if absorbing, history of the Southern Slavs, and must pass on to the occupation of Bosnia and Herzegovina by Austria-Hungary. It will be remembered that Servia successfully revolted against Turkey soon after the first quarter of the nineteenth century, when she became a principality, merely "tributary" to Turkey. The effect on the kindred peoples in Bosnia and Herzegovina was to render them restless under Turkish misrule. Unfortunately, they had not, as Servia and Bulgaria each had, the nucleus of a homogeneous nation within their borders, and the spiritual allegiance of a large proportion of their people to the Sultan, as Khalif, made a national rising almost impossible. Then, as now, the three Churches divided the Bosnians and their neighbours in the Duchy. This was the more to be regretted since the peasants suffered even more than the Servians or the Bulgars, being taxed and oppressed by their own Mussulman nobility quite as much as by the Turkish officials sent to govern them. The *kmet*, or serf-peasant, was perhaps the most backward agriculturist in Europe, and his country was in a state of anarchy. This was the condition of affairs when, in 1875, the people of Bosnia-Herzegovina made the attempt to throw off the Turkish yoke. The rebellion, fostered by a secret society, the *Omladina*, spread during the next year to Servia and Bulgaria. The resources of Servia were soon exhausted. Then came the Russian intervention, ending in the abortive treaty of San Stefano (which created a great Bulgarian principality, stretching from the Danube to the Ægean) and the Congress of Berlin in 1878. The proposed limits of Bulgaria were greatly restricted. Servia obtained independence, but in the delimitation of her frontiers, her needs and aspirations were ignored. It was decided that Austria-Hungary should be allowed to "occupy" Bosnia-Herzegovina, and to place garrisons in the *Sanjak* of Novi-Bazar. As a matter of fact, Russia had engaged in her secret convention with Austria-Hungary (in January, 1877) to make this concession to Austria if the latter remained neutral in the Russo-Turkish war. Bismarck permitted, or probably initiated, the "occupation" as a means of driving the wedge of Austro-German influence through the heart of the Southern Slavs, and the British plenipotentiaries acquiesced in the scheme as the best way to secure order in this turbulent corner of the Balkans. The Turks, it must be noted, had the foresight to extract from Count Andrassy a secret protocol acknowledging the "provisional" character of the occupation.

The Austrian occupation was not accomplished without severe opposition on the part of the people, and the guerilla warfare, which lasted four years, cost Austria two hundred officers and five thousand men before the country was pacified. There is no doubt, having in view the great difficulties to be encountered, that Austrian rule has, on the whole, been directly beneficial to the people. This is largely due to the policy initiated by the Hungarian pro-consul Kallay, to whom the government of the country was first entrusted. Railways, telegraphs, and roads have been pushed on, and whether their object is strategic or otherwise they are a direct and undeniable boon to the country. Attempts have been made, by means of model farms, to improve the primitive agricultural methods; schools have been established, hospitals built; and, in short, a veneer of European civilisation has been spread over the land. It is now quite easy for an ordinary tourist to visit this little-known country without getting out of the range of good trains and decent hotels, and the Austrian Government has even provided mountain huts and guides for climbers who wish to explore the Dinaric Alps. Of course the Austrian veneer and the comfortable hotels do not exist off the beaten track, but a great deal has been done to bring the peasant in touch with the world of progress and change, of which he had hitherto been in entire ignorance, wrapped in true Oriental lethargy. The drafting of the young men into the army, which involves spending some time outside their own country, will undoubtedly have a great effect on the next generation.

In Serajevo one sees the old and the new style side by side, with a very curious effect. This is how it was described in "The Whirlpool of Europe," by my wife and myself (published in 1907), which gave an account of all the countries and peoples under the Austrian Crown:—

"The five-and-twenty years of Austrian occupation have not in Sarajevo, the capital, done more than place a surface crust over the lives of the people. Even here one may turn out of one's modern hotel and in a few steps enter the bazaar—that labyrinth of lanes, flanked with wooden booths in front of stone buildings. Here is no trace of the West. The barber plies his trade; the shoemaker displays his peaked slippers of red or yellow and patches his customers' worn goods, spectacles on nose; the silver and copper

smith has his little furnace and apparatus of primitive simplicity; the tailor sits cross-legged on his bench; and the sweetmeat-seller greets one's nostrils with the odour of *ghee*, to be smelt a long way off. Most characteristic of all is the be-turbaned old greybeard, seated cross-legged before his door, smoking sedately and imperturbably his cigarette or hookah, and surveying the world with the indifference of age-long philosophy. Through the murmur of sounds that fills the heavy air, laden with the many smells of an Oriental bazaar, comes a familiar *clang*—the importunate jangling of the bell of an electric tram which glides along near by, in vivid contrast to this bit of the old world."

The people, even in their Mussulman dresses, betray their Slav origin very plainly.. It is true one sees the dark hair and brunette complexion often associated with the East, but it is, in reality, the colouring of Southern Europe; there are many more fair types and blue eyes. Both men and women are well grown and sturdy, and have the open glance of Europe, and not the inscrutable, expressionless eyes of the East. The peasant dresses are very picturesque and distinctive, each village having its own peculiarities, and a wealth of embroidery is used to glorify the rough homespun stuffs of which clothes are made. The patterns are distinctly Eastern in feeling and colour, and the Austrians, who are anxious to preserve the artistic sense of the people, have established schools for carpet-weaving, embroidery, and silver-work, in which the old Turkish designs are followed. Unfortunately, the æsthetic sense of the Austrians has not prevented them from building the most hideous (though doubtless sanitary) bare barracks, Government offices, and public buildings, which so grievously mar the picturesqueness of Bosnian towns.

The peasantry are almost entirely illiterate, the only education hitherto having been the provision made by each Church for teaching her own people. Like all Slav peoples they love songs, ballads, and stories, and have long and wonderful tales of their ancient heroes, who have gradually become semi-mythical personages with magical powers. This was the only form in which the Slavs could preserve their national traditions, and for centuries the Servians have kept their national sentiment alight with no other fuel than these folk-songs and legends. In Bosnia there is the same persistent racial feeling, and both Turks and Christians tell the same stories and sing the same songs of their great ones in the past. So far I do not think these have been collected or written down, though it is to be hoped that this will be done before the spread of education destroys oral conditions. There are several collections of Servian folk-lore and songs, and they have a wild, melancholy beauty which is essentially Slav in spirit, resembling the music of Chopin.

A curious feature of Bosnian peasant life is the *Zádruga*, or village community, which is still to be seen in its primitive form, though it is becoming rarer. All the Slav races practised some form of communism at times, and it survives in the system of landownership in Russia, and many other Slav countries. In the *Zádruga* all property is held in common, and the members eat together, pool their earnings, and cannot act without common consent. The following graphic description of a *Zádruga* is taken from an article by Miss Thompson in the *Nineteenth Century* for April, 1907;—

"In one of the *Zádrugas* that I visited, I found the huge family of fifty persons at breakfast. A Bosnian hut, two-thirds of which is conical, grey-shingled roof, marks the quickest and most natural transition from growing trees to a human habitation. The interior consists usually of a single room, dark and not over cleanly—for the peasant, though he never fails to enumerate pure air and pure water as the chief charm of the village, is, as a rule, careful to exclude both from his house and his person. This *Zádruga* consisted of a group of four or five huts and as many barns, perched on an isolated spur of the mountains. The men of the party—five brothers and their sons and elder grandsons—were seated on low stools round a *sofra* or table about twelve inches high; at a smaller and still lower *sofra* sat boys of the next age, while at a third sprawled the babies—there seemed at least a dozen of them. Directly the meal was over, the men went off to their work; one brother started on a two days' journey with pigs to sell at Sarajevo, another for a distant pasture in the hills, while the little boys of six and seven were sent off, not without tears, to watch the goats; and three, a few years older, started, equally unwillingly, for the district school, some two hours away. The women, who had waited on the men, and taken their own meals later—breakfast for all had consisted of a paste made of maize flour, which each kneaded and dipped into a central bowl of leeks boiled in water—then set to work methodically at the needles, their looms, and their cheeses. If the Slav peasant may be sometimes accused of laziness, his wife atones for it by her ceaseless industry. She does not spend time in cleaning her house, it is true, but she spins, she weaves, she dyes, she prepares all the household food, she makes all the household garments. There is no field labour of which she does not do the lion's share. Small wonder that a Bosnian woman is

seldom as good-looking as her tall, well-formed, fair-haired husband."

Though the material progress of the country under Austrian administration cannot be denied, it must not be supposed that the people are contented. Apart from the very natural objection always entertained to an alien rule, the bureaucracy is somewhat narrow and unyielding in its methods; monopolies are granted to foreigners (mainly German) which bear heavily on the natives; very few careers are open to the natives, and they are not allowed the safety-valve to the national consciousness of freedom of speech, press, or public assembly. They feel themselves, in fact, in far greater danger of being denationalised than they were under the Turk. Their natural discontent is fanned by foreign agitators, and the result is a very dangerous condition of affairs.

And now let me try to summarise the recent events which have brought this strange, semi-Oriental country so prominently before us to-day. In January of last year considerable excitement was caused by the announcement that Austria-Hungary had obtained from Turkey a concession to survey a line through Novi-Bazar to connect the Bosnian system with the existing line running southwards to Salonika. It was apparent that this was a part of the Austro-German scheme for cutting the Slavs of the Balkan peninsula in two, and preventing Servia from connection with Montenegro, or ever reaching an outlet on the sea. Russian sympathies were now enlisted afresh on the side of the Southern Slavs, for since her defeat in the Far East the greatest Slav power has turned once more towards the Near East. A great outcry, therefore, arose, and as a counterblast to the Austro-German line a Slav railway, from the Danube to the Adriatic, was projected, which would cut the Novi-Bazar line at right angles and emerge on the Adriatic. The Italians, like the Serbs, though of course in a lesser degree, are interested in this railway project which would open to them new and profitable markets both in the Balkan States and in Southern Russia. The agitation on this score decreased, however, as no practical steps were taken. Then suddenly (in August, 1908) came the wonderful news of the successful revolution in Turkey, and the granting of a constitution to all the peoples within the Ottoman Empire. Put crudely, there is no doubt that this sudden change forced the hand of Austria-Hungary. Such a hold had been established on Bosnia-Herzegovina that the eventual annexation of that country was inevitable, but the new school of politicians, who are now replacing the aged Emperor Francis Joseph in the control of affairs, decided that a favourable moment for making the annexation was to be found while the new régime in Turkey was still weak, and while Russia was occupied with internal difficulties. Bulgaria, which might have joined Servia in protesting on behalf of the Slavs in Bosnia-Herzegovina, was bought off by the promise of support should Prince Ferdinand throw off the nominal suzerainty of Turkey. It is believed in well-informed circles that Prince Ferdinand forced the pace, and that Austria had not intended the blow to fall quite so soon. However that may be, her action aroused opposition in Great Britain and France, where much sympathy is felt for the young Turks; in Russia, where the Neo-Slav movement—the new development of the Pan-Slav propaganda—is very strong in the Duma and among the middle classes; and eventually in Italy, whose interests were threatened. Germany alone supported her ally Austria, although it is difficult to reconcile her attitude with the friendship she has always professed for Turkey.

At the present moment the situation is an *impasse*. Austria and Bulgaria have certainly set aside the Berlin Treaty, but, even if a Conference of Powers is called to consider the situation, it would be impossible, in the division of opinion that exists among the Powers, to restore the *status quo*. As a nominal concession to Turkey, Austria withdrew her garrisons from the *Sanjak* of Novi-Bazar, but she would never have done so were she not well aware that in her fortresses and railways, which extend to the frontier of that region, she already holds the key to the strategic position.

Whatever may be the reasons or justification for Austria's precipitate action, the result has been to raise an acute crisis in the Near East. The immediate consequences, outside the Balkan countries themselves, are the revival of Italian Irridentism, Russian Pan-Slavism, and the Slav-German race conflict in Austria, while a severe strain has been put on the reforming government of Turkey. Within the Balkan countries we find that Servia, baulked of her one great national ambition—the recovery of her ancient boundaries and an outlet on the sea—is rendered almost desperate. There is undoubtedly a feeling among the more hot-headed Servians that their whole future is imperilled and that they may as well risk all

upon a desperate hazard, in the belief that intervention would come to their assistance should their independence be threatened. The close racial ties between the Bosnians, Servians and Montenegrins makes it impossible to foresee how far an armed movement might spread if it once broke out in any part of this mountainous corner of the Balkans. The strongly awakened national and racial consciousness of the Southern Slavs has to be balanced against the individual weakness and poverty of their States. At any moment a chance "incident" on one of the frontiers might fire the mine, and, as is the case with all Slavs, reason and diplomacy would be powerless in the face of the reckless daring and fervid patriotism which would be roused by the shedding of Slav blood.

Therefore, while Turkey and Bulgaria may come to terms, even though the Bulgarians are "spoiling for a fight," since powerful influences are at work to prevent a conflict in that quarter, and while Austria may also effect an amicable arrangement with Turkey, it is difficult to see how the question of the Southern Slavs is to be finally adjusted unless Austria can placate them in sections, and so divide them. Concessions of a comparatively unimportant nature might induce Montenegro to keep quiet, and a liberal policy, with a promise of autonomy in the near future, would discount a good deal of the agitation in Bosnia and Herzegovina. As I have already pointed out, the latter have profited materially by Austrian occupation but have lost the right of free speech. Moreover, the Catholic propaganda of the Austrians and the power attained by the Church in the provinces have given offence to the bulk of the people, who are Orthodox or Mussulman Slavs. There is not lacking, however, among the more far-sighted Bosnians an appreciation of the fact that, as their country will have to be under the wing of one or other of the Powers, they will find the shortest cut to comparative freedom lies through that local autonomy which they can legitimately demand from Austria. The probable reorganisation of Austria-Hungary on a Federal basis—which is believed to be the aim of the present heir to the Habsburgs—should be an additional incentive to the acceptance of the situation.

Finally, we come again to the question of Servia. Her position is one of grave danger. The sympathy felt for her after her brave struggle for liberty has been largely discounted by her recent history, and if she feeds fantastic schemes of greatness on the hopes of European intervention she is, in my opinion, deluded. She has to remember, too, that she lies right across the path of certain ambitions—the way to Salonika lies "through the valley of the Morava," that is through the heart of Servia. She has been so much occupied with political schemes that her internal development is still at a very low stage, and the uncertainty of her political conditions has hitherto prevented the investment of foreign capital which is needed to develop her rich natural resources. A policy of extreme prudence and care for her own affairs, with less energy spent on Pan-Slav propaganda outside her own boundaries, are, I believe, the only means by which Servia can preserve herself from disaster.

The spectacle of these Southern Slav countries, whose people exhibit so many splendid qualities but yet do not have that instinct for government which characterises some less gifted races, is rather a melancholy one. In the tangle of mountains, races, and religions which make up the Balkans, one fact stands out pre-eminent, and that is that the people need peace above every other thing—a breathing-space in which to develop themselves and their resources, and to get a truer perspective on their position in Europe. To the great Powers who control the destinies of these small ones peace is no less essential, but it is not quite clear that Austria-Hungary, with the great military power of Germany behind her, realises this or is prepared to "seek peace and ensue it." It is this uncertainty which makes many of us await with anxiety the melting of the Balkan snows, which puts an end to enforced inactivity in those regions.

DISCUSSION.

Mr. Chedomille Mijatovich (formerly Servian Minister) said the Bosnian question was one of life and death to the Servian nation, and as a Servian he wished, on behalf of all his countrymen, wherever they were, to express their grateful thanks to the author for his impartial paper. Servians still hoped that justice would be done to them as a nation, when the great civilised Powers of Christian Europe met in conference; and if that was the case, then the difficult and unfortunate questions which had been raised against their wishes and expectations would find some sort of satisfactory solution. Servians desired that the civilised world should be correctly informed what kind of a nation they were, and that they were deserving of its sympathy. The very best type of the Servian nation, mentally and physically, was to be found in Bosnia-Herzegovina.

The Servians who did so much in olden times for the splendour and glory of the Ottoman empire were almost exclusively Bosnian and Herzegovinan Servians, the finest leaders of armies whom the Turks had at the time they conquered Servia coming from those two countries. He was personally in favour of good relations existing between Servia and Austria-Hungary, but he regretted from the bottom of his soul the great injustice which Austria had done to Servia, to all Slavs, and to Austria-Hungary itself. Count Julius Andrassy told him in 1869 that Austrian statesmen had no objection to Bosnia and Servia being united, because they were one nation and people, and that he had signed a secret Convention with Servia, by which Austria-Hungary acknowledged that fact, and that they would not oppose it. What happened between that time and the Treaty of Berlin in 1878, he could not say, but everything changed. Servians had hoped that by cultivating good relations with Austria they might open that country's eyes so that justice would be done to them, but, unfortunately, without success. Mr. Colquhoun had referred to certain delusions which the Servians might possess, but they knew clearly what was their national duty, and they intended to do it. They intended to explain to Europe the claims of the Servian nation, and God helping them, they would do their duty, even if they were left absolutely alone.

Miss Edith Durham said that having been twice through Bosnia and Herzegovina she thought the author could not have had very much personal and direct intercourse with the peasants of those countries from the remarks he had made. She experienced great difficulty with the officials when starting on her second journey. She had to obtain permission to travel in the interior, and as soon as the official was aware that she could speak the language and would not require an interpreter, every possible difficulty was put in her way. After making an application for the use of a pony and two guides, she was informed that there were no guides in the country, and was offered the official's servant for a fortnight. She accordingly travelled by train, but the officials sent on telegrams ahead of her, with the result that she was met by the police agent at the places where she stopped, and after being shown a few buildings the suggestion was made to her that she had seen everything, and that she had better take a ticket on to the next place. She did not go to the country for the purpose of seeing what the Austrians were doing, but as a result of the treatment she received she thought they must have some object in view, and made up her mind to ascertain what it was. After some difficulty she got off the route which had been mapped out for her by the officials. At the first place at which she arrived she was met half an hour afterwards by the Governor who, after enquiring as to her papers, sent her off to the next place early the following day. She did not see the Governor at the next place, and consequently had a good many walks in the country, experiencing no difficulty in finding a guide. She was asked by the people if she could help in obtaining contraband arms from England, because the one thing they desired was freedom. She could not see, from her travels, that the peasants had received any benefit whatever from Austrian rule, as she had never seen so many wretched, under-fed peasants in any other country. Austria boasted that she had restored law and order to the country, but travelling was quite as safe in Servia and Montenegro. The peasants were ground down, were miserable slaves, and very much overtaxed. They used to have free rights of felling in the forests, but the concessions had now been sold, and the only right the native possessed was that of working in the forests for a few pence a day.

Mr. G. de Wesselitsky stated that he was an Herzegovinian by origin, and at the Berlin Congress he represented both that country and Bosnia: and in the name of his brethren in London he thanked the author for his impartial paper on a subject which was the central question of international politics. In support of Miss Durham's statement as to Austrian rule, he wished to quote an authority from the other side, viz., Baron Burian, the Finance Minister of the Austrian-Hungarian Empire, and the supreme administrator of Bosnia-Herzegovina, who, in his Report for 1906, expressed his regret that the Government had not been able to solve the agrarian question, the necessity for which was the foremost motive for the occupation given at the Berlin Congress by Count Andrassy. An even more candid admission of Baron Burian in his Report was that the industrial progress did not as yet profit the great mass of the population. Baron Burian undoubtedly wished to do good; but his first attempts to win Bosnia-Herzegovina by kindness were frustrated by his colleagues in the Government, and he had been obliged nnder force to change his policy. The question of the tithe was a very important one. In former times the proportion of tithes was determined by commissions on the spot according to the possibilities of the coming harvest, whereas now it was determined at the district Government offices by a functionary who received 6 per cent. on the valuation, so that naturally it was to his interest to value the harvest as high as possible. The natural wealth of the country, the forests and mines, had been conceded to foreign companies. The labour of the people of the country was not utilised, foreign workmen, very often Germans, being employed, so that the proceeds went out of Bosnia; and even the price of the monopolies was paid into the treasury of Austria-Hungary and not into the provincial treasury. With regard to public works, all kinds of great buildings, which were not necessary for the country but were generally destined to attract foreign tourists, and give them an idea of the splendid civilising work being done in the provinces, had been erected. There were railways 1,260 kilometres long in Bosnia-Herzegovina

some of which were built by the Turks; and during the same period that those railways were constructed, 1,300 kilometres were built in Servia and 1,600 in Bulgaria. In addition to that, the railways in Bosnia-Herzegovina were of the narrow-gauge type preventing through communication. Statistics with regard to educational facilities also proved conclusively that greater progress had been made in this respect in Servia and the four new districts which she acquired under the Treaty than in Bosnia-Herzegovina. The authorities fostered artificially an inferior minority of the population, who only numbered 150,000 before the occupation, but who now, by conversion and colonisation, numbered 300,000. Not even Austrian Slavs or Austrian Germans were brought in, most of the colonists being Germans from Germany. On the other hand, the Mussulmen were constantly emigrating. The population of the towns had entirely changed. He protested against the comparison often made by enthusiasts of the Austrian administration, that the work of Austria in Bosnia could be compared with the work of Great Britain in India, it being a gross injustiee to this country and an insult to common sense, because Austria-Hungary kept in Bosnia-Herzegovina, with its 170,000 inhabitants, more troops than England needed to govern 300,000 millions of Indians.

Mr. Louis Felberman said that Mr. Mijatovich had suggested that the author was sympathetic with the Servian cause, and that the whole of Europe was also with them. He did not hear Mr. Colquhoun say anything in his paper specially defending the cause of any particular nation, nor did he hear him say that the Servians had any special grievance. Personally he was a Hungarian, and as such he contended that Hungary had as great a right to Bosnia-Herzegovina as Servia had. If all the principalities in the Balkans were restored to their proper owners, Bosnia-Herzegovina naturally belonged to Austria. Mr. Wesselitzky had endeavoured to prove that Bosnia had not benefited by the Austria-Hungarian occupation; but those who had seen the Bosnian and Servian exhibits at the Paris and Brussels Exhibitions would, he was sure, not share that opinion. Even if not so many schools had been built in Bosnia as in Servia, they contained more pupils and possessed better professors. With regard to the agrarian question, Baron Burian was a very honest politician, who desired to see Bosnia-Herzegovina placed on the same level as the other parts of the Austria-Hungarian monarchy, but unfortunately, although much money had been spent, owing to the natures of the people, a long time was necessary to accomplish this purpose. He strongly contended, however, that Austria had fulfilled its mission most loyally, and introduced civilisation into the country.

Mr. Colquhoun, in reply, said he was not a traveller of yesterday, but a man who had been an administrator and observer, and the author of some books which were still standard works; and his view of the whole question was that it was necessary, in speaking of the countries referred to in the paper, to try to be impartial and fair. No service was done to the Slav countries by exaggeration or arraigning the government of Austria-Hungary, which was, as governments went, trying to do its best. He was perfectly sure that anyone who went to countries, like India or Egypt, avoiding the officials, and listening to the stories of the Bazaar and the peasant, would not come away with a correct view of those countries. From a very long experience of Oriental countries he knew it was exceedingly dangerous to trust exclusively to accounts received from muleteers, innkeepers and peasants. He assured the audience that when he visited Bosnia he was not one of the gentlemen who were so frequently entertained by the Austrian-Hungarian authorities; he received nothing from them in the way of assistance beyond that accorded to any traveller passing through a country. Everyone who had thought over the situation must feel that it was of the greatest importance to the whole of the small Slav States, to the Balkans, to Europe and, not least, to Austria-Hungary herself, that justice should be done to the small Slav States, for he was convinced that should war unfortunately break out, while there could be little doubt as to the immediate result, the ultimate result would not be in favour of Austria-Hungary, because there would be established in the Balkans what had been well called a running sore, which the Austrians would find it impossible to heal. It was true, as Miss Durham said, that there was an enormous volume of emigration from Bosnia-Herzegovina, and so there was also from Croatia and from Hungary itself, which was a blot on Hungary that Hungarians did not like. In writing about such countries, anyone who was an experienced traveller knew that those who tried to hold the balance even were liked by neither one party nor the other, but that was the inevitable fate of everyone who tried to be fair. It had always been his wish to be fair and impartial, and he had tried to be so in the paper he had read.

On the motion of the Chairman, a hearty vote of thanks was accorded to Mr. Colquhoun for his instructive and interesting paper, and the meeting terminated.

THE TREATMENT OF INEBRIATES.

The report of the Departmental Committee appointed to inquire into the operation of the Habitual Drunkards Act of 1879, and of the Inebriates Act of 1898, makes it clear that these Acts have failed of their purpose. The failure of the 1879 Act is mainly due to the fact that it was shorn of all compulsory features, and became an Act merely permitting the establishment of retreats into which

inebriates could not be admitted except when they themselves desired control. Moreover, there was an absence of accommodation for poor inebriates. Every year hundreds of persons signify their willingness to submit to treatment, but are unable to procure it owing to the impossibility of finding money to pay, wholly or partly, for their own maintenance. The Inebriates Act of 1898 has not been more successful in operation. The intention of the Act is not explicitly stated, but the Committee assume it to be (1) to protect the community against inebriate offenders; (2) to provide facilities for their reformation. The implication from the terms of the Act is that both these objects are better attained by relatively prolonged detention than by repeated committal to prison, which has been found useless by long experience. During the nine years the Act has been in force fewer than 3,000 persons have been committed to reformatories under its provisions—about 400 from sessions and assizes, and 2,600 by magistrates. The failure to apply the Act is due to difficulties connected with the administration of Sections 1 and 2, and to the fact that no obligation is laid upon any authority or person to provide accommodation for committed inebriates, or to maintain them during sentence. When it is remembered that the offenders who have been convicted and sentenced for drunkenness (during the period in which the Act has been in force) in Courts of summary jurisdiction have numbered more than a million and three quarters, it will be obvious that the Act has had no real influence in restraining intemperance. The original reference of the Committee was extended by an authorisation to "investigate the value of existing methods for the treatment of inebriety by the use of drugs," but the Committee are of opinion that treatment by drugs cannot possibly supply the penal element which is present in all sentences of inebriates to reformatories.

The investigations of the Committee led it to conclude that this penal element, to be of any use to society, should be brought to bear upon the drunkard at an earlier period of his career. At present, any person who drinks to excess, without committing a public offence or crime, can continue his drunken habits indefinitely, notwithstanding that he may produce over many years untold misery to his family, and ultimate expense to the community. Such persons often, at length, commit offences, nd then may be dealt with under the Act of 1898; but in very many cases they pursue their disastrous habit until they die of disease engendered by it. In the opinion of the Committee, there is no reason to doubt that if there existed means by which they could be placed compulsorily under control at an early period in their career, a large proportion of them could be restored to decency and usefulness, and an incalculable amount of misery and poverty might be prevented. At present, the only possibility of control for such a person is the somewhat remote chance that he may be persuaded or coerced into making a "voluntary" application for admission into a retreat. The existence of this class of drunkard, and the necessity of legislation for them, were fully recognised by the Committees of 1872 and of 1893, but hitherto Parliament has declined to adopt these stringent views as to the compulsory commitment to retreats of inebriates. The present Committee propose a graduated mode of procedure, beginning with measures of the mildest character, and not increasing their stringency until the milder measures are found to be ineffectual. They propose that the inebriate may (1) enter into a statutory obligation before a Justice of the Peace to abstain from intoxicants for not less than one year; or he may (2) apply to a Justice of the Peace for the appointment of a guardian named by himself. In the event of the pledge being broken, or the guardianship proving insufficient, power is to be given "to a relative, friend, or guardian voluntarily appointed to petition a judicial authority for a compulsory order of guardianship, or for committal to a retreat." The Committee do not make it clear whether there must in all cases be a breach of the statutory obligation, or proof of insufficiency of guardianship, to bring this compulsory power into operation: all they say is that such breach or insufficiency "would be ground for such petition." If the intervention of the judicial authority is to be limited to cases where the expedients named have been tried and failed, it may be doubted whether the proposed Act would be of much avail. The Committee seem to shrink from the logical consequences of their own conclusions, influenced no doubt by the belief that even now Parliament may not be prepared to apply compulsory powers to persons who have committed no public offence, although recognising that recent legislation shows that the Legislature no longer hesitates to enforce restrictions on the liberty of persons whose unchecked vagaries are clearly contrary to the public weal. Probably not much will be done in the way of lessening the inebriate population until the punishment which drunkenness now entails upon the offender when he is brought before a magistrate is made much more drastic in the case of offenders brought up a second or third time, and power is given to the judicial authority to commit an inveterate drunkard to a reformatory with or without a preliminary penal sentence.

THE RAILWAY IN ECUADOR.

In his report on the trade and commerce of Ecuador (No. 4173, Annual Series) Mr. Consul Cartwright refers to the effect that the near completion of the Guayaquil and Quinto Railroad Company has had on the economic problems of the coast. In former years all supplies of potatoes, vegetables, corn, hay, beans, and other similar food material had to be imported from Chile, Peru, &c. To-day Guayaquil exports to less favoured countries. Prior to the advent of the railway, the

interior, or *sierra*, drew nearly all its supplies (except food) from Guayaquil and the exterior, and had to pay for them in hard cash, whereas to-day it draws less and pays not in cash but in produce. Then, again, with the increased facilities, Quinto and the surrounding country is drawing from Guayaquil and the intervening districts, supplies of cotton, wool, and other fibres that enable her to manufacture unbleached cotton (*liencillo*), casinettes, linen cloths, baizes (*bayatas* and *bayatillas*), rough casimies, towels, &c., thus rendering the whole interior, from Latacunya (south of Tinto) to the northern provinces of Colombia, independent of all imports of such articles from foreign countries. This alone causes considerable increase in the activity of the country, and is due to the fact that the railway has afforded facilities for the conveyance of adequate machinery and materials to the country. Flour mills and allied industries are also springing up, and the elevated districts of Ecuador will in the course of a few years be, says the Consul, in place of dependent districts, self-supporting, and able to export to foreign countries.

TEA CULTIVATION IN INDIA.

The total area in India under tea cultivation in 1907 was 542,737 acres as against 535,546 in the previous year, the greater proportion of this being in Eastern Bengal and Assam, while the production for all India was 247,500,000 lbs. With regard to green tea the reported production was above 3,500,000 lbs., apparently less than the figures for 1905 and 1906. The former statistics are, however, not entirely reliable. The amount of tea exported by sea declined by 6,607,446 lbs., the direct shipments to the United Kingdom (169,500,000) being decreased by nearly 7,000,000 lbs., while the proportion taken by our country also declined. On the other hand direct exports to Russia have increased by over a million and a half pounds, or nearly 12 per cent. Canada imports decreased by nearly 10,000,000, but the United States took a little more than they did in 1906. To Australia and New Zealand the shipment increased by rather more than 1,500,000 lbs., but this is partly accounted for by the fact that the cargo of tea lost in the steamer *Fortunatus* was replaced by later shipments. Of course a good deal of re-exportation from the United Kingdom takes place, but, as students of trade statistics are aware, the tendency of sea-borne trade is for direct shipments to the country of consumption to be more and more preferred. Thus the re-exports to Russia decreased by 3,750,000 lbs., figures which detract from the importance of the large increase in the direct shipments to that country. The imports of foreign tea into India were 6,400,000 lbs., most of which was used for blending with the Indian produce. As to the total capital employed in tea cultivation in India, that of the joint stock companies amounts to about £16,000,000 sterling, of which nearly five-sixths represents the capital of the companies registered in London, and a little more than one-sixth that of the Indian companies. It has been calculated that between January, 1905, and November, 1907, the value of shares in 170 tea companies registered in London advanced by no less than 50 per cent. The total number of employees in the Indian industry is estimated at more than half a million, but this is probably a good deal below the actual numbers, which are very difficult to ascertain with accuracy.

THE PORT OF LONDON AUTHORITY AND ITS ORGANISATION.

The new Port Authority for London, under the Port of London Act, will be constituted immediately, and it is probable that the total number of nominees will run to thirty. The chairmanship, as is known, has already been conferred on Sir Hudson Kearley, and the invitations to the various bodies, representing the payers of dues, wharfingers, and owners of river craft, are actually being issued. Eighteen members of the Authority are to be elected by these three interests, but the electoral machinery being as yet quite in embryo and unprepared, the first appointments are to be made by the Board of Trade, in consultation with the associations and such individuals as may be considered most nearly representative of, or acquainted with, the collective opinion of the respective bodies. In addition to these there will be ten members who, for want of a better term, may be described as official members. One will be appointed by the Admiralty, two by the Board of Trade, one of these two being a representative of labour interests; four by the London County Council, two being members of that body and two outsiders; two by the Corporation of the City of London (one a member and one a non-member), and one a nominee (probably a member) of the Trinity Board. This will make twenty-nine, and the vice-chairman (unless he happen to be one of the foregoing, which is hardly likely) will make thirty. In addition to the above, the Port Authority will have the power of co-opting two members conversant with dock administration, but it is hardly likely to avail itself of the permission till it is in a position to see who are to constitute the new body.

COTTON GROWING IN NORTH CHINA.

It has been stated by the American Vice-Consul at Tsingtau, that Shangtung and the whole of North China proper grows much more cotton than is generally supposed. The special cotton district of Shantung is north of Kaumi, in what is known as the Hauli region. Many of the old maps show a large shallow lake here, and it is in the bed of this former body of water that hundreds of acres of cotton are now found. By a careful system of drainage, the natives have divided the entire lake off into a series of ditches and high fields made of the earth removed

from the ditches. By a system of locks and gates, they are also able so to regulate the moisture that a crop is almost certain, regardless of atmospheric conditions. The seed is planted in very carefully-tilled fields late in May, and after the plants are well up, they are thinned out and topped. This causes the bushes to remain low and well spread out. When they are being topped another supply of rich bean-meal fertiliser is added, and the fields are very carefully cultivated until after the plants have finished blooming. Early in October the crop begins to be ready for harvesting, the last cotton being picked about five weeks later. In order to separate the fibre and seeds, a device consisting of two foot-power wheels is used. These wheels are arranged like a clothes-wringer, and small teeth pull the fibre through, while the seed drops to the ground, being too large to pass between the rollers. The surplus seed is then ground to an oil, which the natives cannot refine or clarify, hence it is used only for primitive lamps. The stalks of the old plants are used for fuel, as is all waste vegetable matter in China. The cotton, after passing through the native ginning process, is by no means the fluffy batting the natives desire, hence they have invented an instrument which closely resembles a large violin bow. With the thong of this bow they beat the cotton until it is all separated and soft, being then ready for the market. The staple of the native cotton is very coarse and short, and it is therefore of little value for weaving, being used almost exclusively as wadding for the heavy winter garments and for neck wraps. Foreign imported cotton is used in manufacturing. Experiments on a small scale, with a few plants, have recently been made within the confines of Tsingtau. Of some five hundred bushes only a few dozen produced, the cold weather apparently setting in before the crop had matured. All of the plants were healthy, grew well, and all had bolls. As the cold weather set in rather early last year, more extensive tests are to be made this year. American seed is said to have been used along the line of the Shantung railway, chiefly near Ching Chou-fa. The results were not satisfactory. The seed was planted early, grew very well, and the stalks were always loaded down with a heavy crop, which, however, was checked each year by the first cold weather. The cotton of the American plant seemingly takes longer to mature than that of the native cotton plants, and the season is too short to allow the crop from the imported seed time to mature. On the whole it may be said that, considering the poor staple, and the poor methods of ginning and cleaning the cotton in vogue in Northern China, there is at present little possibility of the industry extending beyond its present bounds. The crop is nevertheless a profitable one for the Chinese farmer; and as the cotton-wadded clothes are not likely to be superseded for a very long time by any other form of dress, the short staple cotton fills a demand, and will therefore always be found in North China.

ARTS AND CRAFTS.

The Camberwell School of Arts and Crafts.—The annual exhibition of the Camberwell School of Arts and Crafts has grown to be of some importance from the craft school point of view. Not only has the number of classes held in the school itself increased very considerably, but there are also various outside centres affiliated with it. The exhibition occupies this year (for the first time) three rooms and embraces examples of almost all the artistic crafts. It is due probably to the influence of Miss Houston and Miss Wright that embroidery forms so large a part of the show; for that branch of the work is certainly more than ordinarily interesting. The students are evidently taught not only a variety of stitches, but how to use them effectively, and the embroidery design is altogether very fresh and pleasing. If one wanted to cavil, one might grumble at the absence of care in some of the outlines and a certain want of sweetness in the curves, but there is nothing else to find fault with. The examples of embroidery applied to costume, too, are very satisfactory, and show how a small amount of quite simple work carefully planned to its purpose can be the making of an otherwise perfectly plain dress.

Bookbinding, again, is very largely represented, and some very good forwarding is shown. Some of the cover designs, too, are very well spaced and in good proportion. The weak point seems to be the lettering which is not always so clean or so well-considered as it might be. Some of the half-bindings are very pleasing in colour; but it hardly seems worth while saying, for example, that a plain half-bound book, not even lettered on the back, with back and corners of blue leather and sides of a lighter blue linen, was designed and executed by so and so. It takes a little thought and some taste to get just the right tones and just the right proportions in a half-bound book, but it scarcely amounts to design There seems to be a tendency in the schools of art and crafts to dignify everything—every slight re arrangement of old forms or half-unconscious remem brance of something seen before, or any little piece o tasteful arrangement, with the name of design. In sense, of course, it is design, but if we are to use th word so freely for every little exercise that a chil could do, we shall want a new expression for seriou design.

House-painting and decorating are subjects rath neglected in some schools, but at Camberwell som very good work was shown, far more tasfeful than th kind of thing usually is. There were some good friez and all-over repeating patterns, a little herald painting, and several examples of lettering. By t way, while the Roman letters were very satisfactori treated the Gothic ones left something to be desire

Pottery is one of the crafts which, owing to t difficulty of doing practical work in them school, have only recently taken their places London schools of art. Unfortunately, it is alm inevitable that a good deal of the pottery done

classes should be rather amateurish. The pots shewn at Camberwell included, however, some pleasing vase shapes and some very satisfactory examples of experimental glazes.

Though practically all craft schools have metal-work and jewellery classes, the best work in these subjects tends rather to come from the schools where they are the special feature of the institution than from the all-round schools. The Camberwell work is, however, quite up to the mark. The enamel, though not very wonderful in itself (that is hardly to be expected of student work) shews that the pupils are taught to have some definite aim in their heads, and to get the particular effect they want rather than to depend upon some lucky chance which may, or may not, put everything right in the fire.

It is satisfactory to find a school of this type increasingly encouraging the practice of making studies from historic ornament. A goodly number of studies were exhibited, and they showed that the students, especially perhaps in the costume design and embroidery classes, but in the other classes as well though in a less degree, are taught not merely to make elaborate copies of some old work only remotely related to their particular subject, but to take notes and jottings of old things which may help them in their own craft. Historic study is a good thing in itself, but it is still better when it is closely connected with the student's more immediately practical work.

Illumination.—One of the natural results of the revival of script and ornamental writing generally, and of the increased attention paid in recent years to writing and lettering, has been the development of illumination, which for many years had been practically a lost art. Connoisseurs and collectors had been willing to pay long prices for old illuminated manuscripts but modern illumination not only had no market but was practically non-existent. William Morris's wonderful illuminated manuscripts, though admired by the few, were hardly known by the public until after his death.

It is really rather strange, unless it can be looked upon as being by way of a protest, than an age like ours, so full of hurry and rush and commerce, should witness the reappearance of arts and crafts which require so much patient labour as illuminating and caligraphy. But such is the case—and it is not only that here and there an individual settles down determinedly to this kind of work, there are few self-respecting all round schools of arts and crafts which do not boast a class in script and illumination. One wonders sometimes what will come of it all; whether there are enough people who really appreciate the difference between a good printed border and an illumination—and that amongst those who can afford to pay the price for elaborate handwork, to provide employment for so many would-be illuminators. But after all, the practice in care and neatness which such work gives, will probably be of great value to the students, many of whom are allowed in a good deal of their work to be rather careless and inaccurate. Illumination, which is at any rate first cousin to miniature painting, has perforce to be careful, painstaking work, even though the actual drawing of the lines, &c., may be quite fluent and straightforward. Moreover, in this craft, as in most others, there is plenty of room at the top, and it is always within the bounds of possibility that some of the students will get there.

Some Recent Illumination.—There has been no really large and representative show of modern illumination since the last Arts and Crafts Exhibition some three years ago, when the work of Miss Kingsford, Mr. Graily Hewitt, and many others could be seen at the same time and compared; but there happens to have been a very fair amount of illumination to be seen just lately in different parts of London. By-the-way, it is rather odd that, though the teachers of script and of illumination are very often the same, or at least work very much together, the writing almost without exception keeps very near to old models, whilst the illumination is for the most part quite modern in character, founded rather on William Morris's famous illuminated books than on the mediæval service books.

Some quite good simple illumination has been on view at Camberwell, the work of the students there. There is nothing very remarkable, but enough to show what very pleasing simple work can be done by students with a little training. The script, however, is on the whole not quite so good this year as it has sometimes been before.

Miss Jessie Bayes's work at the Grafton Gallery, was of course a very different matter—this is no student work, and not by any means simple but very elaborate painting, remarkable for its charming colour effects. It is not so delicate as Miss Kingsford's work, but is more or less on the same lines.

The work of Miss Edith Ibbs, still to be seen at Quaritch's, is again accomplished, but in quite a different manner. The pages shown are part of an illuminated Communion Service. The decorations are far more traditional in style than is usual in modern illuminations, and it seems quite fitting that, in ornamenting a service book, the artist should have borne in mind the work done in the old service books, missals, and what not, in days gone by. Whichever style may be best in itself, there is an appropriateness in Miss Ibbs's work which would be lacking in that of some of the most competent modern illuminators if applied to this purpose. The specimen to be seen in Grafton-street, comprising as it does, the central portion of the service, affords an admirable opportunity of judging the workmanship, which is unusually delicate and, in treatment as well as in style, compares not unfavourably with a good deal of the early illuminating. It is the intention of the artist to produce six complete services and no more, and the price she asks for them, though not of course small, is very modest considering the quantity and quality

of the work involved. This is partly due to the fact that Miss Ibbs is practical enough to follow the lead given some years back by Mr. Vigers, and to content herself with printed type (admirably set up by the Chiswick Press) for the bulk of the service, and to spend her own energies on the ornamental initials and borders which together with the type form a thoroughly harmonious whole.

OBITUARY.

MAJOR-GENERAL SIR OWEN TUDOR BURNE, G.C.I.E., K.C.S.I.—By the death of Sir Owen Burne, on Wednesday, the 3rd inst., after a long and painful illness, the Society loses one of its most devoted and earnest friends. Elected a member in 1887, at the instance of his life-long friend, Sir George Birdwood, he joined the Council in the ollowing year, and from that date to the present time he continued, with such brief intermissions as the regulations rendered necessary, an active member of it. He served in every possible capacity, as an Ordinary Member, as Vice-President, as Treasurer and (1896-7-8) as Chairman. He was also (in 1895) Chairman of the Committee of the Indian Section. For more than twenty years he was constant in attendance and unsparing in service. He was ever ready to take upon himself any duty in which he could help the Society, or any labour by which he could promote its interests. Though a man of many occupations, and busied with many diverse affairs, official, social, political and religious, he was prepared at a moment's notice to devote himself to the service of the Society and to undertake any piece of work, whether congenial to his own tastes or not, in connection with which his influence could be helpful or his advice useful. It is only those who are responsible for the proper carrying on of the regular work of a great public institution who can realise how valuable such co-operation is, how hopeless would be their task without such devoted aid.

In all Sir Owen Burne must have occupied the chair at some twenty meetings of the Society, besides others at which he was called to preside officially as Chairman of the Council. It was during his tenure of office in 1897 that the London meeting of the International Congress on Technical Education was held. He attended all the meetings, and presided over most of them, making himself especially popular with the foreign delegates, who appreciated his genial courtesy and frank, pleasant manners, and afterwards attributed to his personal efforts much of the undoubted success of the congress. At most of the meetings over which he presided, the subjects discussed related to India or the East, and on these he could speak with authority, but even when the paper was such that he could not deal with it as an expert, his treatment of the topic was always thoughtful and agreeable, tending to stimulate discussion, if it could not initiate it. The last occasion on which he took the chair was a little more than a year ago, when M. Hubert's extremely interesting communication on French methods of colonisation was brought before the Society, and those who were present will remember the graceful way in which the Chairman, after his brief comment on the paper itself, turned to its author and, in his own language, thanked him for bringing before an English audience the valuable experience gained by the administration of another country.

Sir Owen Burne was born in 1837. His father was the Rev. Henry Burne, a clergyman of the Established Church, who joined the "Catholic Apostolic Church," founded by Edward Irving and his associates. He was one of a large family, having had eighteen brothers and sisters. In 1855 he obtained his commission, and after just missing the end of the Crimean war, he was sent to India, where he served with distinction during the mutiny. His services attracted the attention of Sir Hugh Rose (Lord Strathnairn), who appointed him (though he was then only four-and-twenty) his military secretary, and, indeed, continued his staunch friend for life. From this time on Burne's career was political, rather than military. After serving as A.D.C. to Lord Strathnairn during the latter's command in Ireland, he returned to India as Private Secretary to Lord Mayo (1868), and it was in his arms that the assassinated Viceroy died in 1872. His next appointment was that of Political A.D.C. to the Secretary of State for India, to be followed later (1874) by the secretaryship of the Political and Secret Department of the India Office. Two years later (1876) he went again to India, this time as Private Secretary to Lord Lytton. In 1878 he returned to the India Office, where he held his former post till he was appointed to the India Council in 1887. In 1896 he retired. He was made K.C.S.I. in 1879, and G.C.I.E. on his retirement in 1896.

He was twice married, first to the Hon. Evelyne Browne, daughter of Lord Kilmaine, and secondly to Lady Agnes Douglas, daughter of the Earl of Morton.

WILLIAM HENRY VERNON.—The death occurred on the 1st inst. of Mr. W. H. Vernon, one of the best-known landscape painters of Birmingham, in the eighty-ninth year of his age. Early in life he became a student at the Society of Arts, where he drew from the antique, and he afterwards studied for a time in Paris. Throughout his long life he was a diligent worker, and his pictures were shown at the principal exhibitions in London and the provinces. On several occasions he collaborated with the late T. Sidney Cooper, R.A., a notable example of their partnership being the picture "Landscape and Sheep," in which the landscape was painted by Mr. Vernon and the sheep by the famous animal painter. Mr. Vernon was elected a member of the Society of Arts in 1905.

GENERAL NOTES.

Memorial Tablets. — The London County Council have recently affixed to No. 14, Buckingham-street, Strand, a memorial tablet bearing the names, Samuel Pepys, Diarist; Robert Harley, Earl of Oxford, Statesman; William Etty, Painter; and Clarkson Stanfield, Painter. The present building was probably not erected until the latter part of the eighteenth century, but the house which sheltered Pepys and Harley occupied the same site. Here Pepys appears to have lived from 1685 to 1700, when he retired to Clapham, very ill with the breaking out of the wound caused by the operation which he had undergone in 1658. He was immediately succeeded in the tenancy of this house by Robert Harley, who was from 1701-5 Speaker of the House of Commons, and it was in Buckingham-street that there began the friendship between him and Swift, which was only broken by death. The work of collecting his library and the manuscripts which formed the nucleus of the famous Harleian Collection, now in the British Museum, extended over the whole period of his residence in this house, which lasted until the accession of George I., when he retired to Wimpole in Cambridgeshire. William Etty went to Buckingham-street on his return from Italy in 1824, and remained there for 23 years. In this home, "of which I love in my heart every stick, hole and corner," he painted some of his most famous works and enjoyed his social triumphs, numbering among his guests Flaxman, Constable, and Turner. Stanfield's residence in Buckingham-street probably lasted from 1826 to 1831, he occupying the first floor chambers, while Etty resided at the top of the house. The Local Government Museums and Records Committee of the London County Council have also recommended that the residences of Thomas De Quincey, at 61, Greek-street, Soho, and of Sir Joseph Banks, at 32, Soho-square, should be commemorated by means of memorial tablets. They further state that they have suggested to the Duke of Westminster that tablets should be affixed to the residences of Warren Hastings, at 40, Park-lane, of Mendelssohn, at No. 4, Hobart-place, and of Viscount Hill, at No. 24, Belgrave-square; and they also report that, acting upon their suggestion, the City Corporation had decided to affix to The Cedars, Portway, West Ham, a tablet commemorative of the residence there of Elizabeth Fry, the prison reformer.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock :—

February 17.—"The Commercial Relations of France and Great Britain." By Monsieur Yves Guyot. Sir Robert Giffen, K.C.B., F.R.S., LL.D., will preside.

February 24.—"Hand-made Papers of Different Periods." By Clayton Beadle and Henry P. Stevens.

March 3. — "Dewponds." By George Hubbard, F.S.A., F.R.I.B.A. Sir Edward Durning-Lawrence will preside.

March 10.—"The Application ot the Microscope to the Study of Metals." By Walter Rosenhain.

March 17.—"The Musical Aspect of Drums." By Gabriel G. Cleather. [The paper will be illustrated by short selections from the works of the great masters, with the assistance of Mrs. Stansfield Prior at the pianoforte, and a quartette of strings.] Sir Charles Villiers Stanford, M.A., Mus.D., D.C.L., LL.D., will preside.

March 24.—

March 31.—"Afforestation and Timber Planting in Great Britain and Ireland." By J. Nisbet.

Dates to be hereafter announced :—

"Railway Development in China." By Arthur John Barry, M.Inst.C.E.

"The Resources of Peru." By C. Reginald Enock, F.R.G.S.

"The Foundations of Stained Glass Work." By Noel Heaton, B.Sc., F.C.S.

"The Manufacture of Nitrate of Lime." By Sam Eyde.

"The Teaching of Design." By E. Cooke.

"Furniture Design and Construction—Ancient and Modern." By Percy A. Wells.

"The Principles of Heredity as Applied to the Artificial Production of new forms of Plants and Animals." (Aldred Lecture.) By Professor Arthur Dendy, D.Sc., F.R.S., F.L.S.

Indian Section.

Thursday afternoons, at 4.30 o'clock :—

February 25.—"The Buddhist and Hindu Architecture of India." By Arthur Anthony Macdonell, M.A., Ph.D., F.B.A., Boden Professor of Sanskrit, University of Oxford.

April 29.—"The Problem of Indian Labour Supply." By Selwyn Howe Fremantle, I.C.S.

May 27.—"The Function of Schools of Art in India." By Cecil L. Burns, Principal of the Bombay School of Art.

Date to be hereafter announced :—

"Some Phases of Hinduism." By Krishna Gobinda Gupta (Member of the Council of India).

Colonial Section.

Tuesday afternoons, at 4.30 o'clock :—

March 16.—"The Colonial Wool Trade." By S. Banks Hollings.

APRIL 6.—"Ceylon: its Industries and Material Progress." By the Hon. JOHN FERGUSON, C.M.G. The Rt. Hon. SIR WEST RIDGEWAY, G.C.B., G.C.M.G., K.C.S.I., will preside.

MAY 4.—

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

LEON GASTER, A.M.I.E.E. (Editor of the "Illuminating Engineer"), "Modern Method of Illumination."

LECTURE I.—FEBRUARY 15.—*Electric Lighting.* —Introduction — Incandescent electric lamps (historical summary)—Recent developments of Nernst, graphitised, tantalum, osmium, tungsten, helion, mercury carbon, and other lamps—The use of transformers—Effect on the lighting industry (Central stations, manufacturers, and consumers)—National Lamp Association and standard specifications—Lines of future development. *Arc lamps.*—The carbon arc —Open and enclosed arc lamps—Miniature arc lamps —Flame arc lamps—Open and enclosed with inclined and perpendicular carbons—Arc lamps for photographic and medical purposes — Applications and lines of future progress. Use of luminescent vapour and gases—Early mercury lamps—Cooper-Hewitt, Bastian, Vogel, Quartz-tube, Kuch, and Uviol lamps —The Moore system of luminescent gases and its applications.

GEORGE GERALD STONEY, M.Inst.C.E., "Steam Turbines." Three Lectures.

March 22, 29, April 5.

F. W. LANCHESTER, "Aerial Flight." Three Lectures.

April 26, May 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 15...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Leon Gaster, "Modern Methods of Artificial Illumination. (Lecture I.)

British Architects, 9, Conduit-street, W., 8 p.m. Mr. H. V. Lanchester, "Town and Country: Some Aspects of Town Planning."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. T. Okey, "Leaves from an Old Venetian Diary."

TUESDAY, FEB. 16...Statistical (at the ROOMS OF THE ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.), 5 p.m. Prof. William Somerville, "Forestry in some of its Economic Aspects."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. A. Macdonell, "The Architecture and Sculptural Antiquities of India."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. J. Reed, "The Design of Marine Steam-Turbines."

Photographic, 66, Russell-square, W.C., 8 p.m. Dr. Scheffer, "Stereoscopic Projection."

WEDNESDAY, FEB. 17...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Monsieur Yves Guyot, "The Commercial Relations of France and Great Britain."

Meteorological, 25, Great George-street, S.W., 7½ p.m. 1. Mr. E. Mawley, "Report on the Phrenological Observations for 1908." 2. Mr. W. Marriott "The Cold Spell at the end of December, 1908."

Microscopical, 20, Hanover square, W., 8 p.m. 1. Mr. A. A. C. E. Merlin, "A German-Silver Powell Portable Microscope, made in 1850." 2. Mr. G. S. West, "The 'Red Snow' Plant, *Sphaerella nivalis*."

United Service Institution, Whitehall, S.W., 3 p.m. Rev. Canon Edgar Sheppard, "Whitehall Palace and the Execution of Charles I." (Part II.)

Ethological (in the Galleries of the Royal Society of British Artists, Suffolk-street, W.), 8½ p.m. Prof. A. F. Pollard, "Politics and Character."

Child Study, Parkes Museum, Margaret-street, W., 8 p.m. Mr. W. H. Winch, "The Age of Entry into School in its Relation to Progress"

THURSDAY, FEB. 18...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Chemical, Burlington-house, W., 8½ p.m. 1. Mr. F. S. Kipping, "A Study of Some Asymmetric Compounds." 2. Mr. P. C. Ray, "The Decomposition and Sublimation of Ammonium Nitrite under Heat." 3. Mr. H. Hibbert, *a.* "The Estimation of Hydroxyl Derivatives in Mixtures of Organic Compounds;" *b.* "A Simple Method for Determining the Chemical Efficiency of Organic Substances." 4. Mr. J. Thomas, "The Isolation of the Aromatic Sulphinic Acids." 5. Messrs. E. Wedekind and S. Judd Lewis, *a.* "Analytical Investigation of Zirconium Metal:" *b.* "Chlorine Generated by Potassium Permanganate: its Preparation and Purity."

Linnean, Burlington-house, W., 8 p.m. Discussion on "Alternation of Generations of Plants."

London Institution, Finsbury-circus, E.C., 6 p.m. Rev. Canon W. Benham, "St. Paul's Cathedral."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. Hans Gadow, "Problems of Geographical Distribution in Mexico." (Lecture I.)

Optical, 20, Hanover-square, W., 8 p.m. Mr. A. Rosenberg, "Some Instrumental Aids to Hearing."

Mining and Metallurgy, Geological Society's Rooms, Burlington-house, W., 8 p.m.

Botanic, Inner-circle, Regent's-park, N.W., 4 p.m. Prof. W. B. Bottomley, "Remarkable Plants in the Society's Victoria Regia House."

FRIDAY, FEB. 19...Royal Institution, Albemarle-street, W., 9 p.m Sir Henry Cunynghame, "Recent Advances in Means of Saving Life in Coal Mines."

North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, 7½ p.m.

Architectural Association, 18, Tufton-street, S.W., 7½ p.m. Mr. A. N. Wilson, "The Press and Architecture."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Dr. W. C. Unwin, "Standardization in Engineering Practice."

Geological, Burlington-house, W., 3 p.m. Annual Meeting.

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. Annual General Meeting. Discussion on Mr. John Don's paper, "The Filtration and Purification of Water for Public Supply."

SATURDAY, FEB. 20...Royal Institution, Albemarle-street, W., 3 p.m. Sir Alexander Mackenzie, "Chamber Music."

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FRIDAY, FEBRUARY 19, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 22nd, 8 p.m. (Cantor Lecture.) LEON GASTER, A.M.I.M.E., "Modern Methods of Artificial Illumination." (Lecture II.)

WEDNESDAY, FEBRUARY 24th, 8 p.m. (Ordinary Meeting.) CLAYTON BEADLE and HENRY P. STEVENS, "Hand-made Papers of Different Periods."

THURSDAY, FEBRUARY 25th, 4.30 p.m. (Indian Section.) ARTHUR ANTHONY MACDONELL, M.A., Ph.D., F.B.A., Boden Professor of Sanskrit, University of Oxford, "The Buddhist and Hindu Architecture of India."

Further particulars of the Society's meetings will be found at the end of this number.

ANSWERS AND QUESTIONS.

In view of the fact that the Royal Society of Arts includes amongst its members authorities on almost every branch of human knowledge, it has been suggested that the value and interest of the *Journal* would be greatly enhanced if some space were devoted to correspondence of the "Notes and Queries" order. Readers in search of information on particular points which cannot be obtained from the usual books of reference, are, therefore, invited to make their wants known in the *Journal*, in the hope that they may be assisted in their difficulties by their fellow members. Further particulars will be found under the heading "Answers and Questions," on p. 288.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURE.

On Monday evening, February 15th, Mr. LEON GASTER, A.M.I.M.E., delivered the first lecture of his course on "Modern Methods of Artificial Illumination."

The lectures will be published in the *Journal* during the summer recess.

TENTH ORDINARY MEETING.

Wednesday, February 17, 1909; Sir ROBERT GIFFEN, K.C.B., LL.D, F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Burns, Cecil Laurence, 56, Glebe-place, Chelsea, S.W.
O'Farrell, Thomas A., J.P., 30, Lansdowne-road, Dublin.
Pulford, William James, Maldon, Essex.
Ramos, Professor Dr. Mario de Andrade, S. Clemente 295, Rio de Janeiro, Brazil, S. America.
Seager, James Albert, Assoc.M.Inst.C.E., Emerson-chambers, Newcastle-on-Tyne.
Shipley, John Franklin, 63, Shorrolds-road, Walham-green, S.W.
Solomon, Hon. Sir Richard, K.C.B., K.C.M.G., K.C.V.O., K.C., M.A., 42, Hyde-park-square, W.
Tickle, Arthur Henry, 11, Mount-street, W.

The following candidates were balloted for and duly elected members of the Society:—

Birkett, Percy, A.M.I.Mech.E., Explosives Factory, Hiratsuka, Japan.
Johnson, Robert Baines, M.A., J.P., The Hope House, Little Burstead, Essex.
Kershaw, Thomas, M.I.Mech.E., 170, Sannomiya-cho, 1 Chome, Kobe, Japan.
Pearson, Henry C., Messrs. R. and S. Garrard and Co., 25, Haymarket, S.W.

The CHAIRMAN, in introducing the reader of the paper, said that M. Guyot was well-known as a leading politician in France and an economist of distinction, who needed no introduction at the Royal Society of Arts. Many of the audience were well acquainted with his writings and services on behalf of Free Trade and sound economy and finance generally, and were most happy to welcome him amongst them at all times. As an old friend of the author's, it gave him much pleasure to preside over the meeting.

The paper read was :—

THE COMMERCIAL RELATIONS OF FRANCE AND GREAT BRITAIN.

By MONSIEUR YVES GUYOT
(Late French Minister of Public Works).

I.—FRANCO-BRITISH COMMERCE FROM 1786 TO 1826.

As an introduction to the Catalogue of the French Section of the Franco-British Exhibition, I published an essay on the History of Commercial Relations between France and Great Britain. In it I showed the movement of exchange which was brought about between the two countries by the Commercial Treaty of 1786.

The French Minister of Commerce provided a series of statistical tables and graphic drawings in which he tried, with the assistance of existing documents, to show the various phases of Franco-British commerce since 1786.

According to French statistics, the commerce of Great Britain and France showed the following figures (francs) :—

	Importations into France.	Exportations into Great Britain.	Total France.
1786	15,448,000 ..	6,711,700 ..	22,159,200
1787	49,440,500 ..	34,200,000 ..	83,641,000
1792	86,401,000 ..	59,746,000 ..	146,149,000

According to these figures, the commercial treaty of 1786 provoked a great exchange movement between France and Great Britain. On February 1st, 1793, the Convention declared war against Great Britain, and until 1815 we may say that all the Custom-house policy of France was designed to keep out English goods.

It is well known that the Orders in Council and the Blocus Continental strove from 1807 to 1815 to suppress all trade between France and Great Britain, but on the one side the Imperial Government in France, and on the other side the British Government, agreed to grant licences intended to permit violation of their prohibitions. As a result, according to the French figures, Great Britain and France were able, even at the very height of the Blocus Continental, to carry on trade which yielded the following figures (francs) :—

	Imports from Great Britain to France.	Exports from France to Great Britain.	Total.
1810	43,623,000	38,918,000	82,541,000
1811	32,429,000	29,987,000	62,416,000
1812	26,438,000	76,973,000	103,411,000
1813	44,553,000	114,632,000	159,185,000
1814	77,000,000	53,370,000	130,370,000

The Government of the Restoration had not the same reasons for prohibiting English goods as had the Convention, the Directoire and the Empire, but the large owners who were in power, and who, as forest-owners, were at the head of the metallurgical industry, cast France into a fierce state of protectionism. As a result, commerce between France and the United Kingdom fell back, instead of increasing, as a result of the peace.

The following figures give the results for a few years :—

	Imports from Great Britain.	Exports from France to Great Britain.	Total.
1816	45,846,000 ..	26,563,000 ..	72,409,000
1821	46,565,000 ..	31,773,000 ..	78,338,000
1826	23,816,000 ..	47,268,000 ..	71,084,000

but all these figures are only approximate.

II.—CUSTOM-HOUSE FIGURES.

The Custom-house statistics date, in France, from 1827.

From 1827 to 1847, the value of the goods was established by means of evaluation tariffs, which had been determined, in 1826, by a special Commission, and sanctioned by an Order of March 27th, 1827. The values obtained in this manner remained unchangeable, and were called official values.

Since 1847, the basis of evaluation has been determined each year, with the assistance of the Chambers of Commerce, by a Commission annexed to the Department of Trade and Industry. These actual values are intended to set forth, as closely as possible, the average price of each category of goods during the year with which they are concerned.

The price given for imported articles is the price on reaching ports or offices on the French frontiers, deduction being made for customs duties and inland taxes, as also for the discount and usance adopted in trade ; for exported articles the price is also taken from our ports and land frontiers, that is to say, at the point of exit.

In France, it is only since 1860 that count has been taken of the defect in the valuation of exported goods. For a long while the Administration continued to register, for silk goods among others, the gross weight of cases, and thus during the period 1855-1860 the average of riband exports reached the figure of 118,685,000 francs, to the immense stupefaction of the Saint-Etienne manufacturers, who could not justify any similar figure in their books. Even now, whereas for general trade there is but one column indicating the net weight, there are for special trade two columns, one marked "gross" exported quantities and the other "net."

I will speak here only of special trade. This name is given to the trade in national goods, or goods which are part of the general consumption. As a result, we export raw cotton (*coton en laine*) as a national product.

General trade includes transit and bonded goods in *entrepôt*. We count the goods on entrance and on exit, though the entrance and exit do not represent two sets of goods.

The English system does not commit this error. It takes count of the importation of all goods which come into the country, and then distinguishes between the exportation of British goods and that of foreign goods which are again re-exported.

In Great Britain, the figures given in the Customs Tables to 1854 were based on prices dating back two centuries. From 1854 to 1870 the Board of Trade issued statistics according to the present-day prices; since 1870, the registered prices have been those quoted by merchants according to their business transactions, and, as—with the exception of about a dozen articles—they are not subjected to Customs duties, the merchants have no interest in not quoting the correct prices. Such absence of fiscal apprehension ensures to the figures of the British Custom-house a veracity which cannot be attained in any other country; but at the same time they have not the slightest interest for the Custom-house official, as their value does not constitute a basis of taxation.

The English Customs do not estimate; they register the declarations concerning the value at the shipping or unshipping port. The Board of Trade does not appraise. It ascertains. It is the positive method. But even to establish the English figures, it is necessary to have recourse to averages, which do not indicate the extreme prices and the variations which occur at the different periods of the year.

In the United Kingdom the declaration of value made for exportation is subject to verification by the Customs officer, and the shipper who declares an inferior value is subject to a fine, but I do not think this has often been inflicted.

In France, the abolition of exit duties has done away with all means of controlling the exportation declarations, though Article 19 of the law of May 16th, 1864, states that exemption of duties, whether on entrance or on exit, will not confer exemption of the duty of supplying the Custom-house with the particulars prescribed by law, according to specifications and items set forth in the general tariff, subject to a fine of 100 francs in default of such declaration. The declaration is obligatory, its precision is facultative. The law of February 22nd, 1872, imposed a duty of 0·10 centimes (without additional decimes) per package, per cubic metre for goods laded in bulk, per head for live or dead cattle.

Up to about twenty years ago, the trade for the British possessions in the Mediterranean, Malta and Gibraltar, was included. This has not been the case since 1887. Besides, the figure only indicated millions. In some Customs lists, the figures only apply to Great Britain without Ireland: in others to the United Kingdom. On some articles this may amount to a difference of two or three millions, and for the whole list of articles to a difference of 10 to 18 million francs.

The following are, according to the French Custom-house, the variations in the total trade returns, and those in the trade between France and Great Britain, taken in decennial periods.

The proportion per cent. of trade with Great Britain relatively to the total trade is here given.

SPECIAL TRADE—IMPORTATION AND EXPORTATION TOGETHER.

Periods.	With all countries (millions of francs).	With Great Britain (millions of francs).	Per cent.
Official Values—			
1827-1836	1,001	87.6	8·8
1837-1846	1,489	177·6	11·9
Actual Values—			
1847-1856	2,301	406·6	17·7
1857-1866	4,631	1153·9	23·8
1867-1876	6,714	1543·0	22·8
1877-1886	7,808	1522·2	19·8
1887-1896	7,514	1431·7	19·8
1897-1906	9,081	1796·7	19·8
1907	11,819	2281·6	19·2

The proportion of Franco-British trade as regards the total amount of French trade therefore amounts, since the period between 1857- 866, to about 20 per cent.

III.—Franco-British Trade during a few Quinquennial Periods from 1855-1859 to 1902-1907.

It may be useful to show the different phases of Franco-British commerce in quinquennial periods, taking as a starting point the period which preceded the treaty of 1860.

Average per Quinquennial Periods.

	1855-1859.		1861-1865.
Total Importations (millions of francs)	1,732	..	2,447
Increase per cent	—	..	41
Importation of British goods (millions of francs)	294	..	554
Increase per cent	—	..	88

Exportations.

	1855-1859.		1861-1865.
Total (millions of francs)	1,894	..	2,564
Increase per cent	—	..	35
In the United Kingdom	416·6	..	771·4
Increase per cent	—	..	85

During the period which followed the commercial treaty of 1860, while the increase of the importations in France was 41 per cent., and that of total exportations from France was 35 per cent., the increase of importations of British products was 88 per cent., and that of French exports into the United Kingdom was 85 per cent. It is therefore the Franco-British trade which has benefited most by the lowering of Customs duties.

	1855-1859.		1861-1865.
Imports and Exports together	3,626	..	5,012
Franco-British trade	710	..	1325
Proportion per cent.	17	..	26
Total increase of French commerce :—			
Million francs			1,386
Per cent			38
Increase in the Franco-British trade :—			
Million francs			615·2
Per cent			86

If we compare the last quinquennial period of the commercial treaties 1876-1880 with the initial period 1861-1865, we find the following results :—

	1876–1880.
Total importations (millions of francs)	4,292
Per cent	75
Importation of British goods (millions of francs)	615·1
Per cent	11
Exportations (total millions of francs)	3,375
Per cent	31
Exportation into United Kingdom (millions of francs)	953·6
Per cent	23

Imports and Exports Together.

Total amount	7,667
Per cent	52
Franco-British	1,568
Per cent	18

The increase in Franco-British commerce for this period as compared with the period 1861-1866 was 18 per cent.; in the importation of British goods, 11 per cent., and in the exports to the United Kingdom, 23 per cent.

The protectionist reaction obtained a first victory in France. It increased the duties, and altered the *ad valorem* duties to specific duties.

The following is the annual average of commerce during the next period, and its relation to the last period of the commercial treaty of 1860 :—

	1882–1886.
Total importation (millions of francs)	4,453
Per cent	3·7
Importation of British goods (millions of francs)	620·1
Per cent	1·0
Total exportation	3,319
Per cent	1·6
Exportation to United Kingdom	881·3
Per cent	7·5

The importation of British products into France has remained practically stationary, and the exports of France to the United Kingdom have fallen by 7·5 per cent.

Import and export together	7,772
Per cent.	1·6
Total of Franco-British commerce	1501·4
Per cent.	4·2

The decrease in Franco-British commerce was above 4 per cent.

England, by the Convention of 1882, was granted the privilege of the most favoured nation. France had renewed her treaty of commerce with Belgium.

During the last quinquennial period of this *régime* the commercial average gives us the following figures :—

Total Importation (1887-1891)	4,414
Total exportation	3,504
Importation of British goods	552·1
Exportation into United Kingdom	946·9

Relatively to the period 1882-1886, we find, for total importation, a decrease of 39 millions, or 9·8 per cent., and an increase of 5 per cent. for exportation.

For Franco-British commerce, the decrease is 11 per cent. for importation to France, and the increase of exportation of French goods into the United Kingdom is 7·4 per cent.

The protectionist reaction led to the 1892 tariff, with the suppression of commercial treaties and the double maximum and minimum tariff. The United Kingdom enjoys the minimum tariff.

ANNUAL AVERAGE.

	1893-1897.
Total importation	3,835
Importation of British goods	493
Total exportation	3,337
Exportation to United Kingdom	1,010

ANNUAL AVERAGE.

	1898-1902.		1903-1907.
Total importation	4,490	..	5,186
British goods	611	..	661
Per cent.	16	..	8
Total exportation	4,007	..	4,886
Exportation to the United Kingdom	1,193·3	..	1,265·0
Per cent	—	..	6
Importation and exportation	8,490	..	10,072
Per cent.	18	..	18
Franco-British commerce	1,804	..	1,926
Per cent.	18	..	6·7

The total foreign commerce of France has increased during the period 1903-1907 by 18 per cent., and that of the United Kingdom by 11·6 per cent.

Here are the details for the last ten years. At the same time I quote the figures for general trade which show the same error as was pointed out above:—

FRANCO-BRITISH COMMERCE.

	General.			Special.		
1898	652·0	1,313·3	1,956·2	623·4	1,021·6	1,526·6
1899	789·5	1,608·0	1,829·8	590·9	1,238·9	1,829·8
1900	834·6	1,579·0	1,902·2	674·6	1,227·6	1,902·2
1901	701·5	1,552·0	1,800·1	601·9	1,198·2	1,800·1
1902	701·3	1,663·8	1,846·9	566·9	1,280·1	1,846·9
1903	688·4	1,545·8	1,747·9	555·9	1,192·0	1,747·9
1904	649·3	1,569·8	1,737·4	523·5	1,213·9	1,737·4
1905	751·0	1,637·6	2,387·6	592·5	1,256·2	1,848·7
1906	922·6	1,681·6	2,594·2	750·5	1,294·2	2,044·7
1907	1,061·4	1,777·5	2,838·9	883·1	1,368·7	2,251·8
1908 (temporary figures based on prices for 1907)				855·5	1,216·3	2.071 8

As regards the period 1887-1891, we find a fall of 10 per cent. in the importations of British goods to France and an increase of 6·7 per cent. in the French exportation; but the fall in total importations was 13 per cent. and the total exportations decreased by 5 per cent. I know we must not attribute all the commercial movement to the Customs tariffs. Nevertheless, the observer must see that the two set-backs felt by French trade occurred after the aggravation of the Customs tariff in 1881 and 1892. They undoubtedly acted upon the importations, but to the detriment of France. Here are the last quinquennial periods:—

These figures are taken from the "Tableau Général du Commerce et de la Navigation."

In the "Situation Décennale du Commerce de la France," published by the Ministry of Commerce, Ireland is not included, but Malta and Gibraltar are. In the "Tableau du Commerce" of 1906 Ireland is separate. It gives 2,339,000 francs for importation, and 3,485,009 francs for exportation; in 1907, 2,816,000 francs for importation, and 1,518,000 for exportation. It is included in the figures quoted above.

IV.—FRANCO-BRITISH COMMERCE ACCORDING TO BRITISH FIGURES.

The following is, according to the English

figures, the trade between the United Kingdom and France since 1855, taken in quinquennial periods, with the proportionate share of the said trade as regards the entire British commercial budget:—

ANNUAL AVERAGE.

Periods.	Importation from France to the United Kingdom.		Exportation of British goods to France.	
	Total in millions.	Per cent. of entire import.	Total in millions.	Per cent. of entire export.
1855–1859..	12	7·2	6	4·8
1860–1864..	22	9·2	8	5·8
1865-1869..	34	11·9	11	6·1
1870–1874..	40	11·6	16	6·8
1875–1879..	43	11·6	15	7·5
1880–1884..	39	9·7	17	7·2
1885–1889..	39	10·2	15	6·3
1890–1894..	44	10·5	15	6·4
1895–1899	51	11·3	14	5·8
1900–1904..	51·2	9·3	15·2	5·5
1905	53·07	9 5	16·1	4·9
1906	53·87	8·8	20·44	5·5
1907	52·83	8·3	23·5	5·5

The quinquennial periods, with the exception of the first, do not exactly correspond to those which I drew up to show the influence of the Customs policy of France; hence some divergence in the proportions. According to British figures, French importation to the United Kingdom increased by 83 per cent. during the period following the commercial treaty, whereas the exportation of British goods to France only increased by 33 per cent. During the last period of commercial treaties relatively to the first period, the increase of importations, from France to the United Kingdom, amounted to 34 per cent. Each quinquennial period which followed 1880, 1880-1884, 1885-1889, shows a fall of 9 per cent., relatively to the period 1875-1879. The period 1890-1894 is the same, all but one unit; and finally the two years, 1905 and 1906, at the end of twenty-five years, only show a rise of 25 per cent. Our imports represented 11·6 per cent. in the whole British imports; now they represent less than 9 per cent. During the last period of the commercial treaty, the exports of the United Kingdom to France increased by 87 per cent. relatively to the first, whereas our imports into England increased by 94 per cent. It did not suffer after 1880 from the set-back which our importation to England was subjected to. Actually it is 33 per cent. higher than the period 1875-1879.

In relation to the whole British exports, the exports to France were 5·8 per cent. during 1860-1864; they rose to 7·5 per cent. during 1879-1880; they have never exceeded that figure; and since 1895 they have been about 5·5.

These figures show the small share taken in English commerce by exports to France. The share of French commerce with the United Kingdom is much larger. As regards the imports, the proportion was 12·2 per cent. during 1897-1906. As regards exports, it was 28·2 during the same period. England absorbs more than a quarter of the articles we export, whereas we only absorb a little more than one-twentieth of the articles exported by England.

V.—Importation and Exportation, according to the Nature of the Goods.

(French Figures.)

If according to the French Customs figures for the last three years, the definite evaluation of which we possess, we compare the nature of the products which we exchange with the United Kingdom (Great Britain and Ireland), we find:—

UNITED KINGDOM (TEMPORARY ADMISSIONS INCLUDED).

Nature of Import.

Million Francs.

	1905.	1906.	1907.
Food articles	16·2	19·0	25·1
Raw materials......	347·3	456·4	538·6
Manufactured articles	238·8	283·0	330·0
Total........	602·6	760·2	693·7
Bullion and specie ..	423·7	209·5	401·6

Nature of Export.

	1905.	1906.	1907.
Food articles	284·7	241·4	246·8
Raw materials......	239·0	245·3	235·3
Manufactured articles	776·1	828·7	908·8
Total......	1299·8	1314·5	1387·9
Bullion and specie ..	8·0	36·3	370·7

PROPORTION PER CENT. AND PER NATURE OF PRODUCTS.

Importation.

	1905.	1906.	1907.
Food articles........	26·9	25	28·3
Raw materials......	59·9	60	60·2
Manufactured articles	37·2	39·7	36·8

Exportation.

	1905.	1906.	1907.
Food articles	21·9	18·3	17·7
Raw materials......	18·3	18·6	16·9
Manufactured articles	59·6	63·2	65·3

The value of manufactured goods which we send to England is slightly superior to the value of articles necessary for industry which she sends us. These figures do not express the quantities of goods exported in travellers' luggage, which, nevertheless, represents a considerable amount.

VI.—Principal Goods.

I here give the articles imported and exported, the figures of which exceed 20 million francs. I show them for the three years 1905, 1906, 1907, for which we have the definite figures fixed by the Commission des Valeurs de Douane :—

Importation of British Goods, above 20,000,000 Francs, according to French Custom-house Lists.

Special Commerce.

	Millions of Francs.		
	1907.	1906.	1905.
Food articles	—	—	—
Raw materials—			
Wool and wool-waste	74·8	57·8	55·5
Dressed feathers	40·8	58·8	32·1
India-rubber and gutta, raw or prepared	25·0	17·9	18·9
Raw or combed jute	23.8	26·0	23·0
Raw and agglomerated coal	96·0	83·8	97·8
Dressed skins	27·7	22·9	22·2
Manufactured goods—			
Chemical products	20·6	22·2	22·8
Cotton tissues	20·1	16·6	14·7
Woollen tissues	28·7	26·3	23·9
Machines and mechanical apparatus	60·2	44·0	32·0
Ships and boats	21·5	16·2	8·6
Cotton threads	20·3	11·5	29·5

According to French figures, the French exportation into Great Britain, exceeding 20 millions of francs, includes :—

	1907.	1906.	1905.
Food Articles.			
Fresh and salt butter	34·9	42·3	49·9
Wine	39·5	38·9	40·8
Brandy	22·5	18·1	23·1
Table fruit	23·8	24·0	25·8
Unrefined sugar	37·1	25·6	39·7
Potatoes	23·8	24·0	25·9
Raw Materials.			
Skins and undressed furs	21·4	21·8	21·8
Wool and woollen waste	28·5	39·2	34·5
Common wood	24·2	21·4	20·6
Manufactured Goods.			
Threads of all sorts	60·4	41·8	30·5
Cotton tissues	38·0	39·1	25·7
Woollen tissues	127·6	115·6	95·0
Silk tissues and raw silk	166·1	139·6	155·2
Clothes and linen goods	42·3	37·6	42·9
Dressed skins	28·5	34·8	44·6
Skin and leather goods	28·3	42·2	29·5
Motor-cars	60·4	60·6	49·7
Fancy goods, brushes, buttons	34·2	26·0	24·3
Toys	21·4	18·4	19·7
Millinery and artificial flowers	136·8	107·5	97·6

France imports woollen tissues coming from Great Britain, and exports woollen tissues to Great Britain, but these goods are not identical. The cloths which France purchases in Great Britain are for men's garments, the cloths which Great Britain purchases from France are for women's garments.

France has exported more cotton tissues than she imports from Lancashire. Can it therefore be concluded that France can compete with Lancashire? According to the reports of the Customs Commission, the greater portions of these exports represent liquidation stocks, often taken at a loss. They are a species of involuntary dumping, very onerous for those who are obliged to have recourse thereto.

Great Britain is our best client for wines and brandies, but the duties on wines have been raised since April 14th, 1899, in the following manner :—

	Before 1899.		Since 1899.	
	Per gallon.	Per hecto.	Per gallon.	Per hecto.
	s. d.	fr. c.	s. d.	fr. c.
Wine not exceeding 30° (proof spirit, 15 per cent.)	1 0	27 50	1 3	34 35
Wines below 30° up to 42°	2 0	55 00	3 0	82 50
Additional duty for sparkling wines imported in bottles	2 0	55 00	2 6	68 75
Additional duty for non-sparkling wines imported in bottles	—	—	1 0	27 50

It was predicted that these additional duties would bring in £298,000. Here is, according to the "Annual Statement of Trade of the United Kingdom," the quantity of wines of all kinds imported and the total amount of duty received. According to the English Customs, the annual average of wine importations from all sources is:— 1897-1899, 16,370,000 gallons (1 gallon = 4.54 litres); 1904-1906, 12,039,000 gallons; namely, a decrease of 25 per cent. The yield of the additional duties was estimated at £298,000. Whereas the average per year during the period 1897-1899 was £1,368,000, during the period 1904-1906 it produced £1,207,000, that is to say, £161,000 less than was produced by the tax before the additional tax, or a decrease of 13 per cent. The importation increased a little in 1907. It amounted to 12,338,000 gallons, but the tax only brought in £1,199,900.

VII.—Franco-British Commerce; Real Origins and Destinations.

Since 1904, the Commercial Department of the Board of Trade has published a third volume destined to complete the annual statement of the trade of the United Kingdom with foreign countries and English possessions. The object of this publication is to ascertain the real origin and destination of all the products.

Suppose some goods are embarked at Boulogne for London, coming from Italy. They come from France, but their point of departure was Italy. In the study above mentioned, the Board of Trade seems to indicate the producing locality. Those goods will touch at London and start for their ultimate destination, which is New York.

This is what has been found in 1906 and 1907 as regards France.

Imports.

Value of the goods sent from France, either direct or in transit.

	Millions of pounds sterling. 1906.	Millions of francs. 1907.
Total imports coming from French ports	53·8	52·8
Sent from France	47·0	46·3
Re-exported goods	5·8	6·5
Net value of French goods kept in England	41·3	39·8

Exports in France.

	1906.	Total.	1907.	Total.
Total of British goods exported to France	20·4	—	23·5	—
Consigned to France.	20·3	—	23·3	—
Foreign and colonial goods exported	8·3	28·7	10·0	33·5
Consigned to France.	8·2	28·5	9·8	33·1

The British products consigned to France amounted therefore in 1907 to 582 millions of francs, and with foreign and colonial goods to 827 millions of francs.

The English Customs estimate at 1,320 million francs the figure of importation from France to England, whereas the French Customs estimate at 1,388 million francs the exports from France to England, adding to the 1,368 millions of special commerce the 19 millions of exportation for temporary admission, which the English are not called upon to separate in their accounts. These figures of the English Customs are lower than those of the French Customs, whereas they should be higher, since they represent the prices c.i.f. and not f.o.b.

This is, according to the "Supplement to the Annual Statement for 1907," the position occupied by the three nations which traded most with the United Kingdom in 1907.

	Millions of £. Imported.	Consigned.
United States	133·7	134·3
France	52·8	46·3
Germany	36·8	16·0
	Re-exported.	**Retained in U.K.**
United States	10·7	123·6
France	6·5	39·8
Germany	0·7	15·3

Goods Exported to and Consigned to these Foreign Countries.

British Goods.

	Total.	Consigned.
United States	30·0	30·0
France	23·5	23·3
Germany	41·3	41·3

Total Amount with the Foreign and Colonial Goods.

	Total.	Consigned.
United States	66·1	66·1
France	33·5	32·1
Germany	56·7	56·7

As for the exports, the United States and Germany keep all the goods they receive from the United Kingdom. With the exception of about £200,000 we also retain them. But of the goods coming from the United States and con-

signed, the United Kingdom exports 10,000,000 dols. (£2,000,000). There is a difference of £20,000,000 sterling between the goods imported from Germany to the United Kingdom and those which are consigned. On the £36,000,000 sterling of goods consigned from Germany the United Kingdom only retains £15,300,000 sterling, whereas about £40,000,000 of the goods sent from France are retained.

If we take the total figure of goods exchanged between each country, we find for the United States, £189,700,000; for France, £71,900,000; for Germany, £72,500,000. But this equality does not arise from the value of importations of Germany into the United Kingdom; it is the result of the £56,700,000 worth of goods sent from the United Kingdom to Germany. If we only look at the exportation of British goods, the figures for commerce between France and the United Kingdom are superior to those for commerce between Germany and the United Kingdom. We have thus:—

	British Goods		
	Retained.	Imported.	Total.
Goods from France	39·8 ..	23·3 =	63·1
,, Germany ..	15·3 ..	41·3 =	56·6

VIII.—Conclusions.

1. The Treaty of 1880 brought about a great increase in Franco-British commerce; the reactions of the Customs in 1881 and 1892 caused an arrest in this development.

2. As regards the whole amount of trade done by France, the proportion occupied by Franco-British trade is much larger than it is as regards the whole amount of trade done by the United Kingdom.

3. The chief article of importation among British goods, is coal. The proportion of goods necessary for industry, relatively to the whole of British imports to France, is about the same as the proportion of manufactured goods relatively to the whole of the French exports to the United Kingdom.

A few words might be added concerning the revision of Customs duties, which is about to come before the Chamber of Deputies, for discussion. The project has been formulated outside the Government, which has been ill-advised enough to leave the Customs Commission under the direction of M. Klotz, and he prepared the project in the following manner. Each syndicate was asked: "Do you wish to have the Customs duties raised?" Plato has said: "Every man who is asked a good question, gives a good answer." The syndicate replied, "Yes." M. Klotz and his colleague said that it was only a question of raising the general tariff for the Government to be able to negotiate treaties of commerce. But by the law of December 21, 1891, the Government can only make conventions for twelve months. Now, no country in Europe but Portugal has submitted to the general tariff. The Customs Commission has had recourse to "new positions." It allows each Article to retain its number; but it introduces twenty-one new tariffs, as in Article 205 with reference to the duties on cast and refined iron: and it makes the duty as heavy as possible, raising the minimum from 7·50 francs to 40 francs, which makes an increase of 433 per cent. In Article 207, dealing with unwrought iron, the duties are raised from 6 francs to the general tariff of 150 francs, which makes an increase of 2,400 per cent., and from 5 francs on the minimum tariff to 100 francs, or an increase of 1,900 per cent. Such trifling proves the necessity for treaties of commerce which will permit of the lowering of tariffs but not of the raising of them. But, instead of preparing such treaties, they are preparing tariff wars.

DISCUSSION.

The Chairman (Sir Robert Giffen), in opening the discussion, said it was impossible to deal fully with the paper, which would repay careful observation and study, in a short address. He had been much impressed by the smallness of the figures of Franco-British trade during the eighteenth century, which the author made his starting point, a period which seemed remote enough from the present day. But M. Guyot had done well to go back so far. It would be seen from the figures given, that little more than 100 years ago the trade between France and Great Britain was not a twentieth of what it is now, although the population of France had only doubled in the interval, and the population of Great Britain was not more than three times what it was. Such a fact brought home to their minds what they knew from other sources, namely, the very recent beginning of modern industrial development. Machinery, chemical and other scientific discoveries, the improvements in agriculture, in themselves largely due to the progress of chemistry, had made a new industrial world in little more than 100 years. International trade was consequently expressed in much larger totals, just like the more important figures of production and consumption themselves. In recent years, going back to the seventies and eighties, nothing like the same proportionate increase was

found, which was explained in part, as the author pointed out, by the fact of a free trade spurt having occurred after 1880, and then, on two different occasions since, a set-back, following the introduction of Protectionist measures. There was no doubt that free trade measures, when introduced in any country, tended to bring about a spurt, just as protectionist measures, by interposing obstacles, tended to diminish business; but, apart from that, it seemed to him quite according to what might be expected beforehand, that the trade between two countries, like France and England, should at some periods not develop very rapidly, and not so rapidly as other parts of their business. The reason was that they were too like each other. They were both excess-of-import countries, levying tolls upon the rest of the world to which they had lent money, but not upon each other. In that view one of the best part of the author's study appeared to be his account of the actual exchanges between France and England, the articles of the trade, and the proportion of the whole business to the exchanges between them and other countries. The account deserved to be thoroughly studied. Stated popularly, among the most conspicuous exchanges between France and England were, on the one side, export from France to England of Normandy butter, wine, materials for women's clothing, and in recent years one might add automobiles; and, on the other side, among the exports from England to France, English coal, materials for men's clothing, and some kinds of machinery and iron manufactures. These were not the only articles of trade, of course, but they bulked considerably, showing that England and France exchanged between each other comparatively little in amount, and that the trade consisted largely of special articles which the one country happened to have and to be able to supply to the other country which had need for it, coal on the one side and wine on the other being very good instances. That was the real point of importance, he believed, in regard to all foreign trade. It was what some people wanted on one side, and what some people could supply on the other side which mainly characterised the trade between any two nations, whether the fiscal policy was Free Trade or Protectionist; and he for one would like to see more attention given in students' books, both of geography and of political economy, to this aspect of the study. The volume of trade would perhaps be diminished, as he believed, by political and other interferences, but the general characteristics of the diminished and increased trade could not be easily changed. There might be minor changes. France might develop aeroplanes, as she had done automobiles, before this country, and so had more to export for a time; but the great streams of business changed slowly. Last of all, it had occurred to him that the author might have added one chapter to his paper by giving some account of what might be called the passenger business between England and France, which was a most important element in trade itself, and gave no small employment to shipping. In that connection there was undoubtedly a very large exchange between England and France, though which was importer and which exporter it would be very hard to say. The buying and selling of the travellers and tourists from one country to the other was continuous, and resulted very often and to a large amount in dealings of the ordinary commercial kind, the tourist bringing back in his luggage commodities which were undoubtedly exchanged, though they were not recorded at the Custom-house. He would be disposed to say that the passenger business did even more to promote International peace than the extension of ordinary trade. It affected larger numbers of people in both countries than ordinary trade did, people who learned to be neighbourly as they became better acquainted with other countries. He hoped the author would excuse him for the liberty he had taken in calling attention to the point, with which he was sure M. Guyot was in the fullest agreement.

Mr. JOHN CROSS said that in comparing Frenchmen with his own countrymen he had been struck by the fact that their neighbours across the Channel knew a great deal more about financial and commercial subjects than the people of this country, simply because they took more trouble to ascertain the real facts. It was most difficult to get an audience in England to listen to any kind of financial or commercial paper, although this country of all others ought to be most keenly interested in such subjects. There was one great lesson this country ought to learn from France, namely, to be frugal. The reason the French had such enormous financial resources, which had enabled them to bring out a loan of £56,000,000 for Russia without the money market being deranged, was that the people were frugal. The people of this country, like those of many other countries, were extravagant, and the expenditure of the nations of the world was running riot to such an extent that, sooner or later, there must be a tremendous financial crash. Among the upper classes of France, in striking contrast to those of this country, there was a desire to know their financial status, the French woman in every household endeavouring to manage it frugally. Many people in this country thought it was a waste that £150,000,000 in gold should be locked up in the Bank of France. He thought that kind of thing was done to excess in France, but it was not an easy question to discuss; and if a loan of £56,000,000 had to be floated, and one was not sure how it would succeed, it was a very good thing to have plenty of gold in the Bank. The people of this country were much too apt to view the question of Free Trade and Tariff Reform as being the one and only cause, it being merely one among a number of causes, and that was one of the most important things to consider in all questions of trade, and figures of exports and imports. It was

impossible to have really healthy trade if there was unhealthy finance, and that seemed to him the real danger more than any other to all the countries in Europe. If they went on in their present extravagant ways, they would, sooner or later, come to grief. The figures of trade must always be taken in conjunction with financial figures. A great lesson could be learned from France in taking care to obtain true financial data, for instance with regard to the amount of gold in the country. Whenever England was in a financial difficulty it went to the Bank of France for gold. By their frugality the French had constituted themselves at the present day the strongest monetary Power in Europe, although if such a thing had been suggested to him in 1873 he would have said it was impossible.

Mr. HAROLD COX, M.P., expressed his entire agreement with the general conclusions to which the author had come as to the tremendous importance of the proposition now being discussed in France with regard to the new Tariff. He was glad to learn that the Chambers of Commerce in this country were paying very serious attention to the matter, and that protests against the Tariff were being sent in from them to the Board of Trade. Many of the Chambers had gone to the length of saying that if the new Tariff was passed it would seriously interrupt the existing friendly relations between England and France, because, though they all realised that France, in making the new Tariff, was not specially attacking England, but was merely making concessions to certain private individuals at the expense of the whole French nation, it had to be realised that, though her motive was a purely domestic one, the effect of her action was international. It affected England as well as France. Manufacturers at great expense had built up a trade in France, and were able to overcome the existing French Tariff, but if the Government put on another Tariff it would cut off their trade entirely. It was useless to argue with such men, and say that the French Government had no hostile intentions towards them, because they replied that the effect was the same whatever the intentions might be. He, therefore, thought the English people ought to do all they could to back up the little group of Free Traders in France in their fight against the Protectionists in that country, who, for their purely selfish interests, were now driving the French Government into a course of action which must be deleterious to her international relations.

Mr. GEORGE LEDGER said that the author was one of the greatest pillars of Free Trade either in England or France. In France his voice had been that of one crying in the wilderness; he had carried the torch of freedom and duty throughout the country, and he hoped he would continue to do so for very many years to come. He trusted M. Guyot would take the message to the French nation that Mr. Harold Cox had just given, and urge upon them not to do anything to damage the *entente cordiale* which at present existed between the two nations, and as far as possible to mitigate the severity of the new Tariff. Everyone knew how difficult it was to carry any negotiation through when once they had got on the inclined plane of Protection. Last year the author proposed to the English Government that something in the form of a new small commercial treaty between the two countries should be made. There was in France, a tax called the *Surtaxe d'Entrepot*, which was a tax imposed on goods coming from foreign countries to France in vessels that touched at another port before going to France. That extra tax was imposed in the interests of the French shipping industry, but it had done very little good. Supposing a ship, coming from Brazil, touched at the Port of Southampton, when that vessel arrived at a French port, all the goods had to pay a higher duty. The duty was a vexatious one and tended to promote ill-feeling between the countries. The author had tried hard to get the duty abolished, and had suggested that the treaty should be made, as a small beginning from which great things might arise in the future between England and France, whereby France gave up the extra tax, in exchange for which England would reduce to a small amount the tax upon French wines. That would be a most valuable thing to the two nations, but unfortunately the Government was rather timid in regard to the matter, contending that at the Colonial Conference the Colonies asked for a preference, which was refused, and if any such arrangement was now made between England and France people would at once say that England was ready to grant concessions to the foreigner which she would not grant to her own colonies. M. Guyot did not suggest that a preference should be given to France, but simply asked that the duties on wines of a certain strength should be lowered, so that all countries which exported wines of a similar class to England would obtain the same advantage. That was one of the practical proposals which the author had put before the nation; it had not yet produced any immediate powerful result, but he was convinced his action would bear fruit in the early future. He sincerely congratulated the Society on the fact that its members had once more had the opportunity of hearing the voice of one of the most prominent free-traders in the world.

Mr. LEON GASTER called attention to the fact that at the meeting of the British Association held at Cambridge a few years ago, the then Prime Minister, Mr. Balfour, said that the author was one of the greatest friends of England. The Chairman had emphasised the fact that passengers travelling from one country to the other tended to bring about better relationship between the two countries. At the time of the Fashoda incident, when feelings ran very high, the author's articles in the *Siècle* tended to smooth matters; and M. Guyot played a similar *rôle* when, in the course of the Dreyfus trial, he pleaded

that justice should be done. England admired men who came over to this country and told the people how the friendly relations which at present existed between England and France might be continued, and he hoped an exchange of visits would be arranged, so that people in France might know the views of Englishmen on the subject. A great many Englishmen went to France and spent large sums of money there at the fashionable health resorts, and in touring the country; and he wished to inform Frenchmen of a fact, which was not so well known that there were many places in England, Scotland, and Ireland which the French people might visit with advantage.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to M. Guyot for his interesting paper, and the meeting terminated.

PRODUCTION OF WHEAT IN THE BRITISH EMPIRE.

With reference to the question of the production of wheat in the British Empire, Sir GEORGE WATT, C.I.E., M.B., LL.D., on February 2nd, wrote as follows :—Your letter of the 30th ult. reached me here (Dunbar) to-day. Needless to say I cannot be present to-night to hear Mr. A. E. Humphries read his paper on "The Wheat Production of the British Empire." Nothing would have given me greater pleasure than to have been present. I do not know what view Mr. Humphries may take, but to me there has never existed any difficulty in believing that India would one day become a most important safety-valve in the supply of wheat to the British Isles. It is pure clap-trap to speak of India exporting the food of the people. In 1902-3 India exported 63,000,000 cwts. of food stuffs, 47,000,000 of which were rice not in husk and 10,000,000 wheat. Next year the exports were 102,000,000 cwts. food stuffs, of which 48,000,000 cwts. were rice and 43,000,000 wheat. Now of these exports we have the parallel facts, that in 1902-3 there were 183,000,000 acres devoted to food stuffs, of which 71,000,000 were rice, 26,000,000 wheat and barley, and 85,000,000 other food crops. Of the rice area, 40,000,000 were in Bengal and Assam, and 8,000,000 in Burma. Turning once more to the exports, 37,000,000 out of 47,000,000 went from Burma, and thus not from the great rice area, but from a country (Burma) which grows rice purely and simply as its chief exportable commodity. One might similarly analyse the wheat trade, but a point of great moment confronts us in the figures I have mentioned, namely, if India can suddenly increase her contribution in wheat supply from 10,000,000 to 43,000,000 cwts. in one year, to meet a pressing and profitable demand, she can do so again and permanently. India sows to meet a previously ascertained demand. Let that demand be permanent, and the supply will continue. But the British merchants do not wish India to be a permanent contributor, as she would undersell many directions of vested interests. It is on that account that the story has been spread abroad that adulteration is a condition of production. Let refraction be refused, and pure, clean wheat will be exported from India. The British merchant, and he only, can bring this about: India has repeatedly asked to be allowed to participate in the market of pure wheat. Let the buyers say they wish clean wheat, and they will get it. But so long as the present system prevails the Indian wheat supply to England is, by the restrictions of arbitrary trade, prohibited from showing its capabilities. I am writing from memory and with no books before me, and you must, therefore, accept my figures with some reservation. I have for years past held the very strongest opinions of India's capabilities of contributing toward the large cheap loaf of England and am, therefore, sorry that I could not have been present to hear Mr. Humphries.

After reading Mr. Humphries' paper, Sir GEORGE WATT, on February 12th, wrote :—I have no desire to raise superfluous issues since I agree completely with the main points of Mr. Humphries' paper. Of course, I cannot follow him in all his side issues. For example, I distinctly believe in the future of the Indian wheat and flour trades. Firstly, because of the immense possibilities of the available lauds with future extensions of irrigation, together with the improvements in agriculture and transport, to say nothing of the vast tracts of uncultivated land that in the future will come to bear crops; secondly, because of the abundance of cheap labour and consequent cheap production—a population ready to produce whatever is to their own advantage; thirdly, because of the season of the year at which Indian wheat comes into market. To this last consideration I am disposed to attach greater importance than seems to have been conceived by Mr. Humphries. A rise or fall in price in Europe and America is made known in India in time to allow of increased or decreased production. The chief Indian wheat crop that meets the export demand is sown in October or November, and reaped in the following March to May, and thus some months before the succeeding crops in Europe and America. But on another issue I am glad to learn from Mr. Humphries that a more rational view now prevails than was the case formerly, namely the question of adulteration. I have never doubted the desire of the Association of Millers over which Mr. Humphries presided to obtain clean wheat. He speaks of "the shady ways of middlemen," but does not tell us who these gentlemen were, nor whether they resided in Europe or India. So far as I know the Indian merchants, and the Indian Chambers of Commerce, and the Indian Government, have protested in the strongest possible manner against adu

teration, and have affirmed that reform must come from Europe. Mr. Humphries, moreover, does not say that wheat with less than 2 per cent. adulteration will fetch a higher price than wheat with less than that standard of refraction. He seems to discuss only the consequences of higher adulteration. It is this fact that has convinced me (a complete outsider to the trade) that until we can establish the standards at the ports of shipment, and are thus able to avoid freight charges on all adulterations both by land and sea (internal as well as external), no real advancement will be made towards India's full participation in the British supply. Holding that view, I do not consider any material modification of my previous statements as seriously called for. But let me observe that, just as there are special rices grown for export, so there are wheats produced in India that are little if at all suited to the home (Indian) markets. This issue I have dealt with fully in my "Commercial Products of India," and also in a still earlier paper which appeared in the "Journal of the Royal Agricultural Society of England" (1888, vol. xxiv.). The chief wheats exported from India are the soft white (*dudhi*) and the hard white (*bakshi*); these are sometimes spoken of collectively as the *pissi* wheats. Prior to the organisation of a foreign export trade these were very unimportant in India; to-day, over certain tracts of country, they have become of great value, but exclusively to meet a foreign demand. Their production can be extended or contracted directly in response to the indications of profit. This is the feature of India's possibility that, to my mind, mainly concerns the future. The wheats most popular with the people of India are produced in tracts not suited to the *pissi* stock, namely, in the Southern Punjab and certain portions of the United Provinces. These are soft red wheats. The hard red wheats predominate in the Deccan, Berar, and some parts of Bengal; the less valuable hard reds (often forms of spelt) extend further to the west and south, and even to Burma. The change in the route recently taken by the export traffic (alluded to by Mr. Humphries), namely, toward Karachi, in place of Bombay and Calcutta, is to some extent due to the discovery of new areas suited to the wheats in demand by Europe, but I believe very largely so also to improved railway facilities and lower port dues. The change is in fact indicative of future adaptations when the standard of the trade becomes exclusively quality, not degrees of refraction (adulteration).

The foregoing letter has been submitted to Mr. A. E. Humphries, who writes as follows:—

Within the limits of a paper already long, I could not deal exhaustively with the questions raised by Sir George Watt in his two letters, and to do so now would require much space. I can, however, assure him that the representative shippers and millers who dealt with the commercial problems of dirt and extraneous matter in Indian wheat, had a very intimate acquaintance with all the details of the matters before them, and an earnest desire to encourage, by all possible fair means, the export trade in Indian wheat. I dissent in the most positive and unqualified manner from his statement that "British merchants do not wish India to be a permanent contributor" to our supplies of wheat. Although I am a miller, and not a merchant, no one was in closer touch than I with merchants throughout the long communications necessary to bring about the reforms in question, and I never saw or suspected the attitude he mentions. It is impossible to grow wheat anywhere, on a commercial basis, without getting some proportion of admixture, and even in English wheat there is an appreciable proportion of extraneous matter, such as other cereals, weed and seeds, and even dirt and stones, which the elaborate wheat cleaning processes of modern milling successfully deal with. After careful enquiry and much discussion, the Indian wheat committee agreed, I believe unanimously, that the basis as to refraction set out in my paper represented the minimum percentage of extraneous matter which it was reasonable to expect in wheat grown under Indian conditions, so long as that basis had to be applied generally under penalty. I have used the words "under penalty" advisedly, for in effect the terms in force amount to that. We have successfully taken away from traders of easy virtue the temptation to act dishonestly, so that, if such a one mixes dirt with wheat for export, he will have to pay the freight and charges on something for which he gets nothing, or if he should mix barley and other "feeding stuffs" with wheat, he would almost invariably get less for it than if he sold it separately in a proper way.

I am glad that Sir George Watt can take a sanguine view of the prospects of growing an increased quantity of wheat in India. The only comment I need make on that is, that the very large exports of the fiscal year 1904-5 were mainly caused by a bountiful yield per acre in the previous fiscal year. The subsequent crop was grown on the same acreage, but was 2,000,000 tons less; therefore, as the exports represent the excess over Indian requirements, this falling off of, say, 20 per cent. in the total crop or yield per acre, brought the exports down from 43,000,000 cwts. in 1904-5 to 18,750,000 cwts. in 1905-6, though the price remained the same; and the acreage, total yield, and exports have not since recovered, though the conditions were and are favourable so far as price and demand are concerned.

I may be allowed to add that I have recently reported on several samples submitted to me by the Indian Government, for milling and baking tests, and that the Economic Botanist of the Imperial Research Institute, Pusa, has found, and is propagating a variety which, in my opinion, is much superior to any Indian wheat I have ever seen, and which appears to possess the very great further advantage of being highly desirable from the grower's point of view. Clearly an altogether admirable way of helping the exports of Indian wheat!

The following communication has also been received from Mr. A. ROGERS, late Bombay C.S. :—

I wish to call attention to one peculiarity of the circumstances under which wheat is grown in Western India, especially in alluvial soil, in the country around the Gulf of Bombay, in Juzarat, to which no allusion was made in the discussion that took place on Mr. Humphries' paper. This is that its production being dependent on the quantity of rain that falls during the monsoon, which may or may not suffice to moisten the subsoil, the fall of dew that is exhaled after the cessation of the rainy season, must also depend on that previous rainfall. This may be the cause of that hardness of the grain which seems to be favourable in the making of macaroni, in consequence of which, I believe, the greater quantity of this wheat is exported to Italian ports. Whether this quality of hardness would make it favourable for English consumption or not I am not aware, but I think the point is of sufficient importance to bring to the notice of the Wheat Growing Association, in order that the effects of hybridisation of this variety with others may be duly considered. This wheat is drilled in September or the beginning of October, and is reaped by the end of February. It is called "chassia," from "chás," a common furrow.

THE DEVELOPMENT OF SIBERIA.

Siberia, as considered by the Russians, embraces the two political divisions of Western and Eastern Siberia. Western Siberia is composed of the governments-general of Tobolsk and Tomsk, and Eastern Siberia, of the governments-general of Tokatsk and the Amur. The government of Irkutsk is, in turn, divided into the government of Yeniseisk and Irkutsk, and the province of Yakutsk; while the government of the Amur embraces the province of Transbaikalia, the Amur province, and the maritime province (Primorskaya), the latter comprising the Russian half of Saghalien and the Peninsula of Kamchatka. The total area of Siberia amounts to 4,817,687 square miles, and the population to 5,726,719. The population of Siberian cities, mostly based on the 1900 census, is as follows:—Tomsk, 63,533; Irkutsk, 51,473; Vladivostok, 38,000 (the population of this city in 1908 was estimated at 60,000); Omsk, 37,376; Blagovyeshtchensk, 37,368; Krasnoyarsk, 33,337; Barnaul, 29,850; Tyumen, 29,651; Nikolsk, 22,000; Irbit, 20,062. There is very little city life in Siberia. In 1902 only 8 per cent. of the population of Siberia lived in cities, and the general growth of most of the Siberian cities is slow, but there are a few which show very rapid increases. In 1892 the Trans-Siberian Railway Committee was created to colonise the land opened by that railway, and generally to promote the economic development of Siberia. The Committee began at once to promote emigration from European Russia to Siberia, and as a result of their endeavours, not merely did the numbers of the emigrants greatly increase, but their mortality rapidly diminished. The American Vice-Consul at Dalny says that in 1894, of 56,000 emigrants, 3,000 died on the way, while in 1899, of 220,000 emigrants, only 300 died on the way. From 1861 to 1892, 550,000 Russian farmers entered Siberia, while from 1893 to 1899 these figures rose to 1,000,000. Before the Russo-Japanese war most of the emigrants did not go beyond Lake Baikal, remaining in the governments of Tobolsk and Tomsk, and in the district of Akmolinsk.

At the present time, every colonist arriving in Siberia receives thirty-seven acres of land free, paying no taxes on this land for the first three years, and only half the regular taxes for the next three years. The Government has established depôts for the sale of agricultural implements of all kinds to the immigrants, often selling them at reduced rates, and on easy terms of payment. During 1907 over 500,000 persons, according to the latest official figures, emigrated from European Russia to Siberia, and of this number fewer than ever before returned to their former homes. Since the Russo-Japanese war, the traffic on the railway has greatly increased, making it one of the greatest highways of the world's commerce. The journey between Vladivostok and Irkutsk takes four and a-half days, and that between Moscow and Irkutsk six and a-half days, making eleven days between Vladivostok and Moscow. The journey between Vladivostok and Harbin takes thirty-six hours, and Peking may be reached in eighteen or nineteen days, from the chief European capitals, by rail. Siberia has many navigable rivers: the Obi, the Yenisei, the Lena and the Amur, with their tributaries, make communication easy between the interior of Asia, and the Arctic and Pacific Oceans. These rivers are, however, only navigable for a small part of the year, owing to the severity of the long Siberian winter. The Obi and its tributaries water more than 2,000,000 square miles of territory. While the river Yenisei is nearly as navigable as the Obi, it is not nearly so important, as it passes through a less cultivated and more sparsely peopled country. The Amur is a splendid natural highway, busy with traffic, and the Irtysh is a beautiful and much used stream. The Angara, on which Irkutsk is situated, is of less importance, and the Lena is too far north to be of much commercial value. Lake Baikal deserves attention as the sixth in size of all the lakes of the world, being 376 miles long, and from 20 to 79 miles wide. The only canal of importance in Siberia is that between the rivers Obi and Yenisei, joining the cities of Tyumen and Irkutsk. This canal was opened in 1894, and is 62 miles long. The vast area of Siberia is, as yet, scarcely touched commercially, when we consider the richness and capability of the production of its soil, and its constantly growing population. Factories are few, and nearly

all of these are mills, butter factories, alcohol distilleries, tanneries, and foundries, making local products into cheap articles for local consumption. Most of the foundries are very small and unimportant. The Trans-Siberian Railway has made it so easy to bring all goods of the better quality from European Russia and from aboad, that it does not yet pay to manufacture high-class articles for use in Siberia, with its comparatively scanty population. Mining has the greatest future of any Siberian industry. Gold, in placers, is the chief mineral product at present. The chief centres of gold mining are the Altai, the Mariünsk district of Tomsk, the southern parts of the province of Yeniseisk, the Yeneseisk district in the north of the same province, the Nerchinsk and Vitim districts of Transbaikalia, the Olekma and Vitim districts of Yakutsk, and the Bureya and Yeya districts of the Amur province. Some gold is also extracted in the South Ussuri region. No accurate statistics as to the amount of gold produced in Siberia are available. The average annual production of pig iron in the Ural and Siberia (separate statistics for Siberia are not given) for the period 1992 to 1906 was 657,440 tons. The Siberian output of coal, chiefly from the province of Akmolisk, rose from 660,770 tons in 1902 to 1,325,400 tons in 1905. Copper is mined in small quantities. More and more foreign capital is becoming interested in the mineral wealth of Siberia, and American miners are prospecting in those parts of the Primorskaya, opposite and near Alaska. The engineers of the Trans-Siberian Committee have undertaken to investigate thoroughly the mineral resources of Siberia, and have discovered the oil wells of Soudjenka and Tcheremkovo, which furnish some oil for the Siberian Railway. As regards agricultural development, the area under crops in 1906 in the four governments of Tobolsk, Tomsk, Yeniseisk, and Irkutsk was as follows:—Cereals, 9,773,000 acres; potatoes, 171,000; and grass land, 10,645,000 acres. Siberia's exports of dairy products are rapidly increasing, and are said to have a most promising future. The pasturage in the butter-producing region, which lies chiefly in the district of Tomsk is so good that there is 7 per cent, of butter fat in the milk. In the eight Governments of Russia in Asia there are, according to the latest estimate, 4,938,000 horses, 5,712,000 cattle, 11,921,000 sheep and goats, and 198,000 pigs. The fisheries of Siberia are very important, the river Amur being especially rich in salmon. The amount of preserved fish exported from Siberia has considerably increased since 1899, but the high price of salt and tin plate, and the lack of skilled knowledge, are retarding the Siberian canned fish industry. Only a vague idea appears to exist in Europe of the wealth in timber, till now practically untouched, of Eastern Siberia. The forests cannot be compared in density with those of North America, but the area of land lying idle in the maritime province is immense, and only approximate figures as to the extent can be given. According to the estimate of the Forest Department, there are 509,000,000 acres in the Amurand maritime provinces, of which 19,000,000 acres belong to the Cossack administration. Generally speaking, the forests are confined to the sea coasts, river beds and valleys, the high lands and mountains being bare or covered with brushwood. The right to cut timber on a large scale may be obtained either by way of concession for a term of years or by contract. Areas which the Government desire to sell are, from time to time, put up to auction, either at Vladivostock or at Kharbarovsk, the terms and conditions being published beforehand. The fair holds an important position in the commercial life of Siberia. Though not strictly speaking within the limits of Siberia, the great annual fair of Irbit is held so near the borders that it serves as a vast mart for the exchange of Siberian products with those of Europe. In the government of Tobolsk, 507 annual fairs are held; in Tomsk, 68; in Yeniseisk, 13 small ones; and in Transbaikalia (Irkutsk and Yakutsk), from 3 to 12. The aggregate returns of all these fairs is about £5,000,000 a year. The chief exports from Siberia to Russia are grain, cattle, sheep, animal products, furs, game, feathers and down, and the chief imports therefrom are iron and steel, machinery of all kinds, especially farming machinery, cement and manufactured articles of various kinds, these latter coming chiefly from Lodz and other industrial centres in Poland. As there is only one sugar refinery in Siberia, that in the government of Yenisei, a good deal of sugar is imported through European Russia. Tobacco and petroleum likewise are sent from European Russia to Siberia in ever increasing quantities. The balance of Siberian-Chinese trade is greatly in favour of China; Siberia imports £2,000,000 worth of goods from China annually, almost entirely tea by caravan, while Siberia only exports to China £150,000 worth of articles annually, and many of these originated in European Russia, merely passing through Siberia in transit.

THE TEAK RESOURCES OF SIAM.

The increasing cultivation and export of teak in Siam is very fully discussed in the December number of the "Société Belge d'Etudes Coloniales." While the value of the teak exported from India (including, of course, Burma) has diminished during the last nine years from £641,760 to £584,790, the Siamese exports have been gradually developing during the last fifteen years, so that Bangkok itself now exports half as much as India proper and Burma combined. The trunks are felled in the upper reaches of the rivers, and floated down the tributaries of the Menam as far as Paknam Poh, where the various logs are collected and identified by their respective trade marks, and the Government dues paid on each. During the year 1905, 146,753 trunks of teak arrived at Paknam Poh, having been floated down the five principal tributaries

of the Menam, and for the ensuing year a still larger number was anticipated, the greater rainfall having had the effect of releasing a number of logs left high and dry on the banks owing to the comparative dryness of the previous twelve months. There is a Government forest department, which yields a profit to the State of about £33,000 per annum, independently of the timber supplied to the various services having need of the same. The total exports of teak from Siam in 1905 were valued at £641,760. Of this aggregate 45 per cent. finds its way to Europe (mostly to the United Kingdom); 14 per cent. to Bombay, 13 per cent. to Hong Kong, 11 per cent. to Singapore, and 17 per cent. to other destinations. Japan and China have of late increased their demand for teak, and are no longer content with inferior qualities, but insist on having the best. Germany used to purchase her teak in Europe, but owing to the gradual rise in price has had recourse to other woods for shipbuilding. The United States continue to purchase a good deal of teak for shipbuilding, and there is a fair export to the Transvaal for use in the mines and also for house-construction. M. Postin, the author of the article in the *Bulletin*, who formerly held an official position in Siam, says that the competition in Siamese teak is viewed with a good deal of apprehension in India, and that the superiority of the Burmese product is loudly asserted in the Calcutta market, whereas the fact is that the trees of both Siam and Burma are identical (*Tectona grandis*), come from contiguous regions, and are grown in similar ground. M. Postin declares that in length, breadth, and straightness the Siamese logs are, if anything, superior to those of Burma, this being probably due to the larger number of virgin forests still found in Siam. Of course forest conservancy is strictly looked after in Burma, bu precautionary measures were not instituted until un checked felling had made disastrous ravages in the forests of the country, whereas the whole industry is of comparatively recent growth in Siam.

BACON CURING IN IRELAND.

Mr. Loudon Douglas, who is lecturing on "The Meat Industry" at the Edinburgh and East of Scotland College of Agriculture, gives the following particulars of a new Irish agricultural enterprise :—

"A little over a year ago, the first farmers' bacon curing establishment in the United Kingdom was started at Roscrea, in Co. Tipperary, Ireland, and, as the pioneer movement in a new order of things in agriculture, the scheme has been closely watched, not only in Ireland, but in Great Britain, many of the British Colonies, and other countries. The shareholders are 3,800 in number, and consist mostly of the small farmer class, and their individual interests are small, as may be gathered from the fact that their united paid up funds amount only to £11,383, out of which £5,000 is working capital.

"The factory has now completed one year's trading, and it is gratifying to know that notwithstanding the fact that the capital is so limited and that the markets have been unsettled, a handsome profit has been made.

"The gross profit earned was £4,000, and after paying all expenses of working and depreciation, there was a satisfactory balance to the good of £308. The experience of the directors of the factory was unique, as they had constantly to decline business which they could have secured if more capital had been available. For the same reason it is anticipated that, with an additional £5,000 of capital, the gross earnings of the factory would approximate to £8,000.

"Figures like these speak more eloquently than words, and it may now be safely stated that the principle of co-operation in bacon curing has thus been established in the United Kingdom, and the recognition of this will bear fruit in the immediate future in the general impetus which will thus be given to swine husbandry and the general construction of bacon factories in the country, as an essential part of agricultural development."

HOME INDUSTRIES.

Workman Insurance in Germany.—The four Labour M.P.'s who recently visited Germany to inquire into workmen's insurance systems in that country have issued an interesting report. They find "that State assistance has acted as an incentive and encouragement to workmen to make additional provision for themselves and families, through their Trade Unions and private sick clubs. This is especially the case in invalidity and old age." It would be a mistake to suppose that the insurance laws are a benevolence to the working classes. They cost the worker heavily, though the necessary contributions are willingly paid. The entire cost of accident insurance falls, of course, upon the employers; of the cost of sickness insurance, however, the workpeople bear two-thirds, the employer the remainder; and towards the cost of invalidity and old-age insurance the workpeople and employers contribute in equal proportions, while the Empire adds £2 10s. per annum to every pension granted. The number of workpeople of all classes insured against sickness at the date of the last returns, as given by Mr. Dawson in "Evolution of Modern Germany," was 11,903,794: the amount of contributions (workpeople and employers) paid was £13,860,000; and the amount paid by the sickness funds in benefits of all kinds was £13,860,000. The number of workpeople (including agricultural labourers) insured against accident was 18,743,000, and the value of the compensation and benefits of all kinds given to the victims of accidents and their dependents was £8,779,000. The number of persons insured against old age and invalidity was 13,948,200; the amount of contributions (workpeople and employers) paid was £8,064,000, and the sum paid in pensions and other benefits was £5,544,000,

in addition to £2,367,000 paid in subsidies by the Empire. The average amount of the old-age pensions granted was £7 17s., and of invalidity pensions, £7 16s. Between 1885 and 1905, there was paid to insured workpeople in sick benefit £137,564,000; in accident benefit £59,859,000; and in old-age and invalidity pensions (since 1891), £58,108,000; a total of £255,767,000. During this period the workmen paid in contributions £149,583,000, and the employers, £164,908,000; while the Empire contributed subsidies to the amount of £19,340,000.

The Unemployed and the Residuum.—It is interesting to note how German and Englishman agree as to the evidences of destitution and helplessness in the two countries. In the report upon a visit of investigation paid to a number of English industrial towns in 1906 by a deputation of German trade union officials, it is said "In modesty, sense of order, and self-respect, it appears to us the English women of the working-class can learn much from the German. It is, of course, difficult to speak on such a subject without running the risk of falling into unsafe generalisations, and, moreover, many German working-class families are not conspicuous for their virtues. Nevertheless, in no German industrial district will women and children with clothes ragged and tattered be found in such numbers, or in such conditions as in the East of London, and in a working-class quarter of Manchester, though in Lancashire there are comparatively few married women in the textile industry, so that factory work cannot be blamed for this state of affairs, except that most of the women have been engaged in the factory before marriage, and, therefore, have not learned housekeeping." ("Gewerkschaftliche Studien in England," p. 33.) The four English Labour M.P.'s arrive at much the same conclusion. Their report says:—"The members of the deputation were struck by the absence of slums in the manufacturing quarters of the towns visited. Nowhere did they see any quarter that could be classified under the heading 'slum.' The cleanliness prevailing throughout all the towns visited was very remarkable. No beggars, feeble or emaciated men in tatters and rags, were encountered in the streets. Hundreds and hundreds of unemployed were seen by the deputation, but they seemed to lack that dejection and absolute misery that is so frequently met in the streets of English towns."

Child Labour.—The Prime Minister is about to be asked to receive a deputation on the subject of boy labour, which lies at the root of a large part of the problem of unemployment. There are two main classes of boy workers—(1) the class which works at industries the conditions of employment in which are actually detrimental to the moral and physical well-being of those who take part in them; (2) the kind of labour which, though not in itself either morally or physically harmful, is ultimately no less injurious, because it gives the boys employed in it no permanent occupation and no adequate training for industrial life. In the first class may be placed every variety of street trading, also touting for carrying luggage at railway stations, and the position of caddie at a golf course, which alone is responsible for much loafing, idleness, and chronic unemployment in after years. In the second division come van boys and boy carters, boot-blacks, rivet-heaters, and those like them who are employed in big factories at more or less mechanical occupations. It is estimated that, out of London elementary schools, 40 per cent. of the boys go into one or the other of these employments—employments which lead nowhere. In Lancashire, the "half-time" system is still in favour with cotton operatives. It finds favour because it enables families to live in comparative comfort by making a larger proportion breadwinners, and it is claimed for it that it is some sort of a training in the manipulative dexterity required of adults in the cotton trade. But the proportion between men and boys is such that not nearly all the boys who are employed can be retained as men; the operations are largely mechanical, and the withdrawal of all boy labour from the mills might ease unemployment by providing adults with more work. It cannot be well that parents should regard their children as financial assets of the family to be exploited merely for the common fund. It is suggested, among other things, that street trading under the age of 17 shall be absolutely prohibited; that no employer shall be permitted to employ a boy or girl for more than thirty hours a week; that employers shall be required to see that for another thirty hours of the week the boy or girl shall be enrolled at a proper educational institution; and that the age at which the school is left shall be raised, and continuation schools placed on a more regular and ordered footing.

The Numbers Employed.—The Committee on Wage Earning Children were able to show that 9 per cent. of the total number of children in England and Wales were engaged in labour, and the Clerk to the Liverpool School Board showed that 8 per cent. were being employed in his city. The Commissioners came to the conclusion that 200,000 children were working out of school hours, and that probably another 100,000 were engaged as half-timers. Since their report there have been further investigations, which show that there has been little if any improvement. Indeed, two years ago, when the London County Council brought forward fresh evidence in support of their Employment of Children Bye-laws, the percentage of employment was found to be considerably higher than at the time of the Inter-Departmental Committee. Dr. Thomas, who made investigations into the physique of wage earning-children, found that 8 per cent. of the children in the schools visited by him were employed, and that of those engaged in various occupations twenty or thirty hours weekly, 81 per cent. showed fatigue signs, and 44 per cent. nerve signs. Boys engaged as shop boys, who carry heavy weights, showed that 21 per cent. had heart trouble, while in the case of barber boys 63 per cent.

had nerve signs and 72 per cent. anæmia. It is hoped that the London County Council bye-laws will remove some of the worst features of child employment so far as the metropolis is concerned.

Light Dues and Shipowners.—In their report for 1908 the Committee of the Liverpool Steam Shipowners' Association make out once more a strong case for relief in the matter of light dues on shipping. They show that from £350,000 to £400,000 per annum is taken from British shipowners to provide for the cost of lighting the coast line and trade routes of the country, in addition to about £100,000 collected locally for lighting ports and their approaches. The Committee point out that this figure represents in normal times a tax of from 7 to 8 per cent. on the annual profits earned by the total capital invested in British ships. In hard times, such as the present, the percentage is much more and is very oppressive. The Committee urge the Government to abolish the dues, but although foreign practice supports the claim, there is little likelihood that Parliament will consent to do so. The Committee also urge reform of lighthouse administration, their contention being that over neither Trinity House nor the Scottish and Irish Commissioners of Lights is there any effective Government supervision, and that its absence has led to serious abuses.

Automatic Sprinklers.—Some figures have just been published as to the extinguishing of fires by automatic sprinklers, and show how useful they are for the purpose required of them. The figures are not very recent, but they sufficiently indicate the working of the machines. Up to 1905 there were about 2,200 sprinkler installations protecting various classes of property in the United Kingdom, and in 810 outbreaks of fire which occurred in premises thus protected the flames are reported to have been extinguished by the operation of sprinklers in 737 cases, or 91 per cent. of the total number. In 54 cases, or 6·7 per cent. of the total, the fire was reported as partially extinguished by the sprinkler, while they are said to have failed—in some instances at least, through the deficiency of the water supply—in 19 cases only, or 2·3 per cent. of the whole.

OBITUARY.

ANDREW PEARS, J.P.—The death occurred on the 10th inst. of Mr. Andrew Pears, J.P., in the 64th year of his age. Mr. Pears, the great-grandson of his namesake, who founded the soap-making firm in 1789 in a little shop in Wells-street, Oxford-street, worked in the business for over 44 years. He enjoyed great popularity in Isleworth, where the works of Messrs. A. and F. Pears are situated, and he took a deep interest in the well-being of the firm's *employés*. He was a member of the Royal Society of Arts since 1885.

ANSWERS AND QUESTIONS.

NOTICES TO CORRESPONDENTS.

On all communications must be written the name and address of the sender, not necessarily for publication, but as a guarantee of good faith.

Each question or reply should be written on a separate sheet of paper, and should bear such signature of the writer and such address as he wishes to appear.

Questions which can be answered from the usual books of reference, will not be printed.

DISTINCTION BETWEEN ENAMEL AND GLASS.—Is it possible to distinguish scientifically pottery glaze and enamel from glass, and to say definitely where glass ends and they begin? If not, what is to prevent our saying that the art of enamelling is as ancient as glass making?—F. LEWIS.

NOMENCLATURE OF WOVEN FABRICS.—Is there any published work on weaving which sets forth the various kinds of fabrics in such a way as to enable a student of design to distinguish between the various textiles in any museum collection? For example, what does a German mean by half damask?—F. LEWIS.

ANTICIPATION OF THE AEROPLANE.—I am under the impression that the principles of the modern aeroplane were foreseen several centuries ago by one of the great painters—Velasquez, I think. Can any member inform me where I can find particulars of his experiments?—ICARUS.

GENERAL NOTES.

A NEW RUBBER - PRODUCING TREE. — Since the exploitation of the guayule business in Mexico, which five years ago was practically unknown, but which has now grown to one employing several thousand men, and capitalised to the extent of over £200,000, prospectors have been investigating other plants and trees in the district of Durango, in the hope of meeting similar good fortune. The investigators confidently expect that what has been achieved with the guayule plant will be more than doubled. They claim that the sap from the "palo colorado" tree contains over 33 per cent. of pure caoutchouc. According to the American Consul at Durango, several tons of sap have been gathered and are being experimented with. The results of the experiments have not been made public, but everything points to

the fact that the promoters have great confidence in the ultimate results. Of the palo colorado, or cucuracho tree, the Consul has been able to obtain the following information. It grows fairly abundantly on the Pacific slope of the Sierra Madre Mountains at an elevation of from 2,500 to 4,000 feet above sea level, and it forms in many places the line of demarcation between the pine and oak timber. The largest growth is to be found in shaded places—that is, in the shade of other taller trees, or in the mountain ravines, where there is little chance of the sun's rays penetrating. The tree attains an average height of twenty-four feet and a diameter of from eight to fourteen inches. The leaves are large, oval in shape, usually three on a stem, sometimes five, the leaf stem being about six inches in length, and the size of a lead pencil. A person handling the leaves experiences the same sensations as in handling nettles. The tree bears a large white blossom, commencing to flower in May and continuing in flower until late in August. The bark is a dark reddish-grey in colour, very soft and thin. It is tapped in the same manner as the true rubber tree, and when tapped there exudes a thick white sap which, as it is exposed to the air, becomes semi-solid. The pans used in collecting are wet, to prevent the sap from adhering. The season for sap gathering continues throughout the whole year. When tapped the larger trees produce as much as two pounds a day, but after one or two days' run the incision is closed with clay to allow the tree to regain its vitality. It is also stated that the tree is most easy to propagate; branches broken off and pressed into the soil take root and grow.

Opium in Siam.—Although the import of opium into Siam in the last twelve months for which the statistics were complete at the date or Mr. Acting-Consul Dean's report (No. 4176, Annual Series), showed a decrease of 214 cases as compared with the imports of the preceding year, it would seem to be due rather to the growth of smuggling than any diminution in the demand for the drug. The Siamese Government realise the debasing influence of the opium habit on the population, and are fully alive to the importance of lessening the habit as far as possible. But they recognise the futility of any endeavours to prohibit entirely the use of the drug owing to the great difficulty, if not impossibility, of carrying out effective measures for controlling surreptitious traffic and consumption. It seems to be the view of the Government, in which Mr. Acting-Consul Dean concurs, that any such attempt at total prohibition would result only in a considerable loss of revenue without any adequate moral compensation. However that may be, the Siamese Government was recently compelled to take over the principal opium farm, which was unable to meet its obligations, and the business of purchase and sale has since been vested in a separate department of the Miinstry of Finance.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

February 24.—"Hand-made Papers of Different Periods." By Clayton Beadle and Henry P. Stevens.

March 3. — "Dew-ponds." By George Hubbard, F.S.A., F.R.I.B.A. Sir Edwin Durning-Lawrence, Bart., B.A., LL.B., will preside.

March 10.—"The Application ot the Microscope to the Study of Metals." By Walter Rosenhain. R. T. Glazebrook, M.A., Sc.D., F.RS., Director of the National Physical Laboratory, will preside.

March 17.—"The Musical Aspect of Drums." By Gabriel G. Cleather. [The paper will be illustrated by short selections from the works of the great masters, with the assistance of Mrs. Stansfield Prior at the pianoforte, and a quartette of strings.] Sir Charles Villiers Stanford, M.A., Mus.D., D.C.L., LL.D., will preside.

March 24.—

March 31.—"Afforestation and Timber Planting in Great Britain and Ireland." By J. Nisbet.

Dates to be hereafter announced:—

"Railway Development in China." By Arthur John Barry, M.Inst.C.E.

"The Resources of Peru." By C. Reginald Enock, F.R.G.S.

"The Foundations of Stained Glass Work." By Noel Heaton, B.Sc., F.C.S.

"The Manufacture of Nitrate of Lime." By Sam Eyde.

"The Teaching of Design." By E. Cooke.

"Furniture Design and Construction—Ancient and Modern." By Percy A. Wells.

"The Principles of Heredity as Applied to the Artificial Production of new forms of Plants and Animals." (Aldred Lecture.) By Professor Arthur Dendy, D.Sc., F.R.S., F.L.S.

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

February 25.—"The Buddhist and Hindu Architecture of India." By Arthur Anthony Macdonell, M.A., Ph.D., F.B.A., Boden Professor of Sanskrit, University of Oxford. Sir Richard Temple, Bart., C.I.E., will preside.

March 25.—"Man in South India." By Edgar Thurston, Superintendent, Government Central Museum, and Superintendent of Ethnography, Madras.

April 29.—"The Problem of Indian Labour Supply." By Selwyn Howe Fremantle, I.C.S.

May 27.—"The Function of Schools of Art in India." By Cecil L. Burns, Principal of the Bombay School of Art. Professor Sir Hubert von Herkomer, C.V.O., D.C.L., R.A., will preside.

Date to be hereafter announced :—

"Some Phases of Hinduism." By KRISHNA GOBINDA GUPTA (Member of the Council of India).

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock :—

MARCH 16.—"The Colonial Wool Trade." By S. BANKS HOLLINGS.

APRIL 6.—"Ceylon: its Industries and Material Progress." By the Hon. JOHN FERGUSON, C.M.G. The Rt. Hon. SIR WEST RIDGEWAY, G.C.B., G.C.M.G., K.C.S.I., will preside.

MAY 4.—

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

LEON GASTER, A.M.I.E.E. (Editor of the "Illuminating Engineer"), "Modern Methods of Artificial Illumination." (Four Lectures.)

LECTURE II.—FEBRUARY 22.—*Gas Lighting*—Summary of early development of gas lighting—Flat-flame, regenerative, and enriched gas-burners—The incandescent gas mantle—Its theory and action—Soft mantles and other new developments—The Hella bushlight. *High-pressure gas lighting.*—Relative merits of compressed air, compressed gas, and mixture of air and gas—Self-intensifying lamps—Automatic lighting and extinguishing at a distance—Self-lighting mantles—Liquid gas—Modern problems in gas lighting—Recent developments in street lighting in London and Berlin—Candle-power standards versus calorific power of gas; lines of further researches, Livesey professorship at Leeds.

Each lecture will be fully illustrated by working specimens of the lamps and apparatus described.

GEORGE GERALD STONEY, M.Inst.C.E., "Steam Turbines." Three Lectures.

March 22, 29, April 5.

F. W. LANCHESTER, "Aerial Flight." Three Lectures.

April 26, May 3, 10.

CORRECTION.—Mr. Louis Felberman desires that the following corrections may be made in the report of his speech during the discussion on Mr. A. R. Colquhoun's paper, "Bosnia-Herzegovina":—p. 263, col. 1, line 39, for "Austria" *read* "Hungary," and line 55, for the words "Austria had fulfilled its mission" *read* "Austria and Hungary had fulfilled their mission."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 22...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Leon Gaster, "Modern Methods of Artificial Illumination." (Lecture II.)

British Decorators, Painters' Hall, Little Trinity-lane, E.C., 8 p.m. Mr. W. Stewart-Greene, "Art Applied to Decoration."

Surveyors, 12, Great George-street, S.W., 5 p.m. Mr. M. C. Duchesne, "Practical English Estate Forestry."

Geographical, Burlington-gardens, W., 8½ p.m. Captain S. A. Butler, "A Recent Journey through Northern Arabia."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. B. Pares, "Russia: Economic Development."

TUESDAY, FEB. 23...Royal Institution, Albemarle-street, W., 3 p.m. Prof. F. W. Mott, "The Evolution of the Brain as an Organ of Mind." (Lecture I.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Discussion on Mr. S. J. Reed's paper, "The Design of Marine Steam-Turbines." 2. Mr. Magnus Mowat, "Some Recent Grain-handling and Storing Appliances at the Millwall Docks."

Photographic, 66, Russell-square, W.C., 8 p.m. Mr. E. A. Salt, "Some Points in Photographic Shutters, and a Simple Shutter Test, Popularly Explained."

WEDNESDAY, FEB. 24...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Messrs. Clayton Beadle and H. P. Stevens, "Hand-made Papers of Different Periods."

United Service Institution, Whitehall, S.W., 3 p.m. Lt.-Gen. H. D. Hutchinson, "The Fortune of War."

THURSDAY, FEB. 25...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Prof. A. A. Macdonell, "The Buddhist and Hindu Architecture of India."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Sir Max Leonard Waechter, "European Commercial Federation."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. Hans Gadow, "Problems of Geographical Distribution in Mexico." (Lecture II.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Messrs. L. Andrews and R. Porter's paper, "The Use of large Gas Engines for Generating Power."

FRIDAY, FEB. 26...Royal Institution, Albemarle-street, W., 9 p.m. Prof. H. L. Callendar, "Osmotic Phenomena, and their Modern Physical Interpretations."

African, Gaiety Restaurant, Strand, W.C., 8 p.m. Address by the Earl of Crewe.

Physical, Finsbury Technical College, Leonard-street, City-road, E.C., 5 p.m. 1. Prof. Coker, "A Laboratory Machine for Applying Bending and Twisting Moments Simultaneously." 2. Prof. Silvanus Thompson and Mr. E. W. Moss, "The Self-Demagnetizing Factor of Bar Magnets." Prof. Silvanus P. Thompson, "Exhibition of Optical Properties of Combinations of Mica and Selinite Films (after Reusch and others) in Convergent Polarized Light."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Dr. W. C. Unwin, "Standardization in Engineering Practice."

SATURDAY, FEB. 27...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Sir J. J. Thomson, "The Properties of Matter." (Lecture I.)

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FRIDAY, FEBRUARY 26, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MARCH 1st, 8 p.m. (Cantor Lecture.) LEON GASTER, A.M.I.E.E., "Modern Methods of Artificial Illumination." (Lecture III.)

WEDNESDAY, MARCH 3rd, 8 p.m. (Ordinary Meeting.) GEORGE HUBBARD, F.S.A., F.R.I.B.A., "Dew-Ponds."

Further particulars of the Society's meetings will be found at the end of this number.

QUESTIONS AND ANSWERS.

In view of the fact that the Royal Society of Arts includes amongst its members authorities on almost every branch of human knowledge, it has been suggested that the value and interest of the *Journal* would be greatly enhanced if some space were devoted to correspondence of the "Notes and Queries" order. Readers in search of information on particular points which cannot be obtained from the usual books of reference, are, therefore, invited to make their wants known in the *Journal*, in the hope that they may be assisted in their difficulties by their fellow members. Further particulars will be found under the heading "Questions and Answers," on p. 310.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1s. 6d. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURE.

On Monday evening, February 22nd, Mr. LEON GASTER, A.M.I.E.E., delivered the second lecture of his course on "Modern Methods of Artificial Illumination." The lecture was illustrated with apparatus kindly lent by the following firms :—

HIGH CANDLE POWER LAMPS.

Messrs. Chipperfield Lamp Syndicate, Limited.—The Chipperfield self-intensifying lamp.

Messrs. Keith and Blackman.—Complete model plant comprising an electric motor and compressor to light, the lamps exhibited, viz., one 1,500 c.p. high pressure lamp, one 500 c.p. ditto, and one 150 c.p. ditto, being fitted with automatic electric control and electric ignition.

Messrs. Moffat, Limited.—The "Lucas" thermopole self-intensifying lamp.

Messrs. J. and W. B. Smith.—The Grätzin high pressure lamp (3 burners type), 4,500 c.p. ; and the latest model compressing plant, comprising gas engine and compressor mounted on a frame.

NEW TYPES OF MANTLES AND BURNERS.

Messrs. Bland and Company.—Bland inverted burners.

Messrs. Falk and Stadelmann.—Some Vesta-Grätzin burners.

Messrs. G. Hands and Company.—The "Hands" patent cool inverted burner.

F. Mayer.—Self-lighting mantles.

Messrs. Moffat, Limited. — "Mascot" and "Omar" inverted burners.

The Plaissetty Manufacturing Company, Limited.—Various types of "Monarch" and other soft mantles.

Messrs. J. Tuchman and Company.—"Reflex" inverted burners of small and larger types, and

The Universal Gas Methane Buisson Hella Company, Limited.—The Hella Bush mantle.

AUTOMATIC IGNITION SYSTEM.

Messrs. Bland and Company.—Pneumatic distance control of ignition.

Messrs. G. Hands and Company.—"The Norwich" system.

Messrs. Parkinson and Cowan.—An anti-vibrating device.

Distance Lighting Company. — The "Bamag" distance pressure lighter.

Dr. Rostin.—The "Rostin" distance lighting apparatus.

Schweiz-Flüssiggas-Fabrik, L. Wolf, A. G.—The Wolff liquid gas apparatus.

Mr. Gaster's first lecture, delivered on February 15th, was also fully illustrated with apparatus lent by the following firms :—

GLOW LAMPS.

Metallic filaments, mostly using Tungsten as chief material.

Messrs. Body and Company.—Board equipped with latest types of "metallik" filament lamps.

The Bryant Trading Syndicate.—Board equipped with metallic filament lamps; including the 16 candle power 20 watt 100 volt type, and a show-case indicating details of manufacture and materials used.

British Thomas-Houston Company, Limited.—Exhibit of Tungsten incandescent lamps.

Messrs. Edison and Swan and Company.—Show-case containing different types and sizes of metallic filament lamps—including some in which the filament is mounted in an ordinary carbon glow lamp bulb; also a carbon filament lamp of 1,000 candle power working at 100 volts.

The Electrical Company, Limited.—Board equipped with "Aegma" metallic filament and high candle-power 200 volts Nernst lamps, using three burners, giving out 1,000 candle power.

Messrs. Falk and Stadelmann.—Exhibit of several "Sirius-Effesca" metallic filament lamps.

The General Electric Company.—Board equipped with Osram lamps, including the tubular reflecting type, and a 400 candle power lamp, mounted on a fixture used for inverted illumination.

Stearn Electric Company, Limited.—Exhibit of Stearn "Leuconium" type of metallic filament lamps, burning several in series.

Sunbeam Company, Limited.—Exhibit of metallic filament lamps.

The "Z" Electrical Syndicate.—A show-case containing the different types and sizes of metallic filament lamps.

Messrs. Siemens Bros.—A board showing the latest designs of tantalum lamps and clusters of different designs using holophane globes and reflectors.

Messrs. Julius Sax and Company.—Metallic filament lamps in connection with holophane glassware; fixed, one big holophane sphere for lighting up the main staircase of the House of the Society.

ARC LAMPS AND MERCURY VAPOUR LAMPS.

Messrs. Crompton and Company.—Two "Crompton-Blondel arc lamps."

The Jandus Arc Lamp Company, Limited.—Examples of Jandus enclosed and Jandus regenerative flame arc lamps.

Messrs. Marples, Leach and Company.—Examples of Regina, Helia, and Reginula arc lamps, and special photographic arc lamps.

The Oliver Arc Lamp Company.—The Oriflamme alternating arc lamp (magazine type).

The Union Electric Company, Limited.—Duplex Excello arc lamps, provided with new prismatic inner globe and special ventilating arrangement, an alternating current arc lamp, and "Kohinoor" type lamp.

The Westinghouse Company, Limited.—Mercury vapour lamps of Cooper-Hewitt type, including the new "static" type, by which instantaneous ignition is obtained without tilting the tube.

Messrs. A. C. Cossor, Limited.—Specimens of fluorescent and phorescent materials excited by 5 milligrams of radium and other apparatus.

Messrs. Isenthal and Company.—The "Uviol" mercury vapour lamp.

All these were in operation after the lecture.

The lectures will be published in the *Journal* during the summer recess.

ELEVENTH ORDINARY MEETING.

Wednesday, February 24th, 1909; Mr. CARMICHAEL THOMAS in the chair.

The following candidates were proposed for election as members of the Society :—

Beszant, Frederick Henry, 2, Monument-street, E.C.

Coker, Herbert Spencer, District Commissioner's Department, Warri, Southern Nigeria, West Africa.

Leigh, Herbert Hamilton, H.M. Treasury, Warri, Southern Nigeria, West Africa.

Lloyd, G. M., M.A., M.Sc., The Limes, 7, Pepys-road, Raynes-park, S.W.

Kurup, M. N. Paramaswara, The University, Birmingham, and Manaloor House, Olasha, Kottayam, Travancore, India.

Ralli, Dosabhoy Cowasji, care of The Commercial Bank of Scotland, 62, Lombard-street, E.C.

The following candidates were balloted for and duly elected members of the Society :—

Cole, George William, A.M.I.E.E., The Kanan Devan Hills Produce Company, Munnar P.O., S. India.

de Worms, Baron Percy George, F.R.S.L., 21, Lowndes-street, S.W.

Maclaren, William Frederick de Bois, The Rubber Estate Agency, Mincing-lane-House, Eastcheap, E.C.

O'Hagan, Lady Alice M., Pyrgo-park, Havering-atte-Bower, Essex.

Rimell, George J., 53, Shaftesbury-avenue, W.
Wilson, Frederic Frank Munro, Brentmead, Barnfield-road, Ealing, W.
Yeoh Paik Keat, Messrs. Tiang Lee and Co., Kuala Lumpur, Federated Malay States.

The paper read was—

HAND-MADE PAPERS OF DIFFERENT PERIODS.

By Clayton Beadle and Henry P. Stevens.

Since all paper up to the introduction of the Fondrinier machine at the beginning of the last century was made by hand, the subject of this communication deals with any kind of paper made up to that period.

By hand-made paper is meant all paper made on a hand-mould by a vatman in the manner described in text-books. As far as we know the procedure has been the same, at least in general principle, since the first sheet of paper was made, possibly more than 2,000 years ago. One of us read a paper* before the Society of Arts on the subject of water-marking, in which some reference was made to the early history of paper-making. By the aid of this and the bibliography of watermarks subsequently published in the *Journal*,† those who care to pursue the subject can obtain a great deal of detailed information, more particularly on the historical side. Very little, however, is known in this country in regard to the texture and composition of papers of early dates. We shall briefly, after noticing a few somewhat conflicting historical references to the antiquity of paper, refer to the researches done on the Continent on the composition of early papers, give some particulars of the early French papers, and finally add a few remarks on the composition of early German papers, a large number of which are contained in a private collection belonging to one of us. It is supposed that the Chinese first wrote upon bamboo boards, but that from about B.C. 150 to A.D. 150 the usual material was paper made from silk waste prepared by an unknown process.

An American writer affirms that the Chinese were acquainted with paper 123 B.C., and that the merit of the discovery is attributed to the Marquis Tsai, a Minister of Agriculture under the Han dynasty, who is said to have invented and taught in a complete manner the art of paper-making from the mulberry and bamboo, as well as from pieces of hemp, old ropes, and fishing nets. Tsai Lun was born in the province of Hu-nan, and in A.D. 89 was in charge of the Imperial arsenal; the date of his discovery of paper is placed by a Chinese chronicler at A.D. 105. The Chinese seem to have kept the art of paper-making secret for many centuries, for it is not until about A.D. 610 that a knowledge of it was taken to Corea and thence to Japan. The Arabs acquired their knowledge through their conquests in Tartary, and probably at the capture of Samarkand, and it is said to have been introduced at Mecca in the same year, viz., 707. The Moors brought the art of paper-making to Europe early in the eleventh, or possibly the tenth century. The Moors, at the same time, very much improved the treatment of rags for paper-making. We gather this from Koops, who says:—

> "The Christian disciples of Moorish paper-makers, who, since 1085, were in possession of Toledo, and in 1238 of Valencia, worked the paper mills to more advantage than their predecessors; instead of manufacturing paper from cotton wool (which is easily recognised by its being brittle and remaining always yellow), they made it of cotton rags in moulds through which the water ran off: for which reason it was called parchment cloth."

It is not quite clear why paper should be called parchment cloth in consequence of the change in manufacture and raw materials unless it is that paper made from rags and better treated on the mould might be of a harder and more compact nature; that from cotton wool would naturally be very spongy.

Montfaucon examined MSS. on cotton paper in A.D. 1050. The oldest known linen document in Spain is a treaty of peace between the King of Aragon and Spain, A.D. 1178.

Speaking of the Moors, Prescott says:—"The manufacture of paper . . . . was derived through them. M. Casiri has discovered many manuscripts of cotton paper in the Escurial as early as 1009, and of linen paper of the date of 1106." Paper mills are recorded as being in operation in Toledo, making rag paper in 1085. The first manufacture in France is put at 1260. Paper is recorded as being made in Italy in 1367, while linen paper was commonly used in Germany in 1324.

This country was from 1685 much indebted for improvements in paper-making, to the Huguenots, who are supposed to have first produced white paper in 1690.

* Beadle: "Development of Water-marking in Machine and Hand-made Papers," *Journal*, May 18th, 1906.

† "Books on Water-marks," *Journal*, January 29th, 1909.

Of the work of identifying the composition of paper of early dates, that of Wiesner* is of particular importance. Wiesner asserts that the so-called cotton paper (*Charta bombycina*), which is said to have preceded the rag papers, never existed, and that rag papers were not discovered in Europe, but may be traced back to the Arabs in the eighth century, not long after they had learned from the Chinese the method of making a felted paper.

At that time the paper was sized with starch, as was also the case for a considerable period in Europe, but the practical method of sizing with starch was lost in Europe during the fourteenth century. We think we can, from samples we have examined, disprove Wiesner's statement that the use of starch in paper was not re-discovered until after the production of machine-made paper.

In the second of Wiesner's papers† the following conclusions were arrived at :—

The oldest papers from East Turkestan of the fourth to the fifth century consist of a mixture of crude bast fibres from the bark (or outer bast fibres) of various dicotyledonous plants. The bast fibres were converted into paper pulp in a crude mechanical manner.

Similar mixtures are found from the fifth to the seventh century, but during this period papers are found consisting of rags reduced in stamps, and well-macerated bast fibres.

Some of these papers were produced in such a manner that they could be written upon, by the use of gypsum as a backing, by sizing with gelatine from mosses, and finally by the use of starch. While formerly Wiesner could only trace back the use of starch to the old Arab papers, he subsequently traced it through the East Turkestan papers further back to the Chinese.

In the seventh and eighth centuries there alternate papers from crude fibres, generally the bast fibres of various plants and mixed rag and bast fibre papers. The maceration process was improved, but rag papers contain a crude stamped product which is more or less easily distinguished from the accompanying crude bast fibres.

The old Chinese papers from East Turkestan are distinguished from the old Arab papers not only by the crude bast fibres which are found with the rag fibres, but also by the powerful mechanical treatment to which the rag fibres have been subjected.

The Chinese must be regarded as the discoverers of starch sizing. The same method was later on used by the Arabs, who also employed raw starch in admixture with starch paste, thus using the former in the modern technical sense of a "filler."

There were very great difficulties in determining with exactitude the botanical derivation of the fibrous materials in the papers examined. In some cases it was quite impossible to decide the kind of plant from which the fibre was derived, yet it is quite certain that the fibres found in the papers from East Turkestan were entirely derived from the bast fibres of dicotyledonous plants. Among those identified with certainty were the raw fibres of Boehmeria (ramie or China grass, or an allied plant), linen and hemp; the bast cells of Boehmeria, Moraceæ (paper mulberry bast fibres and allied plants), and Thymelaeceæ.

According to Karabacek, the Arabs learnt the method of making paper from the Chinese in the year A.D. 751, but the oldest Arab paper examined by Wiesner was of the year 796, by which time the Arab art had considerably advanced.

Only the dates of a few of the old East Turkestan papers (from Oxford) could be fixed with certainty. In other cases the date could be estimated with more or less accuracy, and in general the results of the microscopic investigation confirmed the dates attributed to the papers. An old Chinese paper from East Turkestan, of the year 768 A.D., is the oldest paper of which we have the exact date and which contains rag fibres, and also the oldest with exact date which is sized with starch. A yet older paper discovered by Dr. Aurel Stein is now in the British Museum.

Wiesner's more recent work comprises the examination of four manuscripts of the eighth century—of these, the exact dates of two are known, viz., A.D. 782 and A.D. 787; the other two are certainly older and belong at the latest to the first half of the eighth century, probably earlier than 719.

These papers were discovered by Dr. Stein in the Taklamaka desert of Turkestan. The results confirm the previous conclusions, viz., that the Chinese at an earlier date than the Arabs, made paper from the bast fibres of dicotyledonous plants using a proportion of rags as a substitute, and that the Chinese were the first to use starch for sizing paper.

* Wiesner. "Ein neuer Beitrag zur Geschichte des Papiers."

† "Mikroskopische Untersuchung alter ostturkestanische und anderer asiatische Papiere nebst histologischen Beitragen zur mikroskopischen Papieruntersuchung."

The four papers comprised in the above mentioned communication consist of:—

(1) A Chinese document dated A.D. 782. The fibres, which include those of the paper mulberry, consist of dicotyledonous bast fibres without any cotton. The paper is unsized.

(2) A Chinese document dated A.D. 787. Fibres as in No. (1). The paper is partially sized and contains unaltered starch granules (probably wheat or barley).

(3) Tibetan manuscript. First half of eighth century. Fibres consist of the well macerated fibres of bast of Thymelaceæ. Contains a considerable quantity of unaltered starch (rice).

(4) Document in unknown language, the local dialect of the Khotan region in the eighth century. Fibres of bast of dicotyledonous plants (probably including Boehmeria) and well macerated, with possibly the addition of rags. Sized with starch paste.

England made no paper prior to the reign of Henry VII. The paper used came probably from Germany, Flanders, and France. Some knowledge of the state of the industry as it might have affected the importation and use in this country can be obtained from records, say, of France or Germany.

During the sixth century papyrus was largely used in France. At the end of the seventh century parchment had largely replaced it. The cotton paper (*papier de damas*) used by the Orientals in the ninth century appears to have reached Europe in the eleventh century, but there is no record of its having reached France. The rag paper known in Europe in the thirteenth century was not known in France until the fourteenth century. This rag paper (*papier de chiffe*) was made of old linen, hemp, or flax. It is recorded that in 1189, Raymond Guillaume, Bishop of Lodève, encouraged the construction of several paper mills in St. Herault at the end of the fourteenth century. The mills of Essonnes and of Troyes were in a flourishing condition. These early French paper-makers established their factories on the borders of streams in districts where they cultivated and spun hemp.

In 1469 the authorities of the Sorbonne invited certain German craftsmen to demonstrate the printing machine. They trained pupils who went to work in the paper mills, thus showing that the arts of paper-making and printing were carried on side by side. Encouraged by Louis XI., the paper-makers and printers increased, and the processes were known and practised throughout France.

The rag paper (*papier de chiffe*) made in France in the fourteenth century is thick, transparent, and stained with spots of water; its uneven surface is very evident both in appearance and feel. The laid-marks are coarse and wide apart, the water-marks large and roughly shaped. The paper is light grey rather than white.

Certain fourteenth century papers used in the South of France are soft and "warm" in colour, the water-marks and chain-marks being rather indistinct.

French papers of the fifteenth century show a marked improvement. They are more supple. They are more even in texture, owing largely no doubt to improvements made in the beating. The laid-marks and chair-marks are thinner and nearer together. The paper is good, and according to Midoux and Matton, always well sized. These authorities failed to find a single sheet of paper made in France in the fourteenth and fifteenth centuries, without a watermark. All water-marks during these centuries were simple, the compound marks not coming in till the next century.

It has been suggested that the custom of water-marking originated in France, where, in the fourteenth century, it was made compulsory for the manufacturers, by the authorities, to seal all their goods with a particular mark by which they could be recognised, and which served as a guarantee of its good quality and its origin. All paper had to be inspected and passed, and any maker who failed to register in this way was liable to a fine. The controllers, known by the name of "Eswards," evidently performed their duties in a thorough and conscientious manner. These marks had to be distinctive and well-known signs for the purpose of indicating the qualities and sizes of the different papers. In early days in France, as in other countries, the makers appear to have produced practically only one quality and size of paper; possibly this was imposed upon them by the authorities.

It is interesting to note the price for paper during the fourteenth century, which is given at 12 deniers the quire, with inferior paper at 10 deniers. The trade having greatly increased at the beginning of the fifteenth century, competition became greater at Laon, and prices had a downward tendency. The manufacture and sale was interrupted at times by the wars. The value of the quire rose to 14 deniers, fell to eight in 1414, to rise again in 1420. It fetched 14 deniers again in 1461, and descended finally to eight deniers in 1500. A

great deal of the paper appears to have been sold by pedlars at the fairs. The Flemish makers brought in their papers and cloths and bartered them for wine. The presence of Provençals and Italians at the fairs, and the settling of Lombards in the important towns of Champagne stimulated the activity of the northern regions of France and were the cause of the establishment of paper works. At first the foreign papers were the most in favour, but their ready sale was checked by the levying of a heavy import duty, which encouraged an increased home production.

and to make a microscopic examination of the fibres, as the earliest paper in this country, of authentic date, and as it is near 700 years old, we asked our friend Mr. John Christie to produce photomicrographs of the fibre.

The figures 2, 3, and 4 respectively show the fibres of the paper—Fig. 2, treated with Schutz's solution (chloride and iodide of zinc); Fig. 3, under ordinary light; Fig. 4, under polarised light with partially crossed nicols. The wonderful state of preservation is remarkable, having regard to the fact that the paper in question is exposed to view in the Museum, where

FIG. 1.

LETTER FROM RAYMOND TO KING HENRY III.

there would be sufficient light to bring about a marked decay in many of our modern papers in a few weeks or months. One of us has carefully examined the paper and sees no evidence whatever of decay, and apart from a certain amount of wear and tear to which it had of necessity been subjected, there is no evidence that the paper or fibres themselves have undergone deterioration during this period. This offers the very best proof of the permanent qualities of the flax fibres for use in the manufacture of papers required to be of a lasting character.

A further sample of paper of a somewhat later date than that of the above was examined microscopically, and was found to consist

The earliest example of authentic date to be found in this country is to be seen in the Public Record Office Museum. This is thought by some to be the earliest extant example in Europe; but for reasons already stated it cannot by any means claim this distinction.

It is a letter from Raymond, son of Raymond, Duke of Narbonne, Count of Toulouse, to King Henry III., praying him to enforce payment of three marks and of one pound in money for three ship loads of salt, sold by R. de Carof to David, the linen-draper of London [A.D. 1216-1222].

One of us, through the courtesy of Sir Maxwell Lyte, was able to inspect this paper,

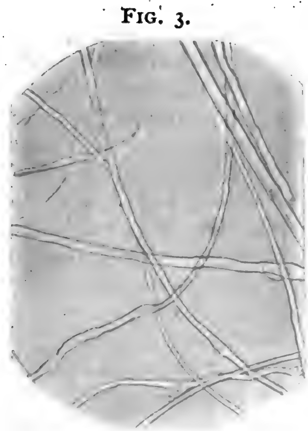
of flax fibres in a good state of preservation. We were also permitted to inspect a number of the early documents on paper in the Public Record Office, many of which had the general appearance of the one above referred to, and also resembled in texture those few thirteenth and fourteenth century papers in our collection.

FIG. 2.

MICROPHOTOGRAPH OF FIBRES TREATED WITH SCHUTZ'S SOLUTION.

We gather through Kirchner ("Wochenblatt," Nov. 14, 1908), that there is a large collection of paper MSS. in the Prussian archives in Berlin, dating from the tenth and eleventh century, but these papers are of Arabian origin.

FIG. 3.



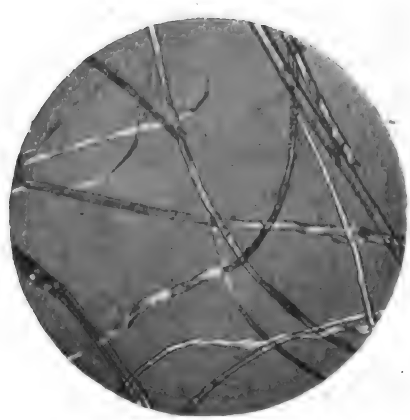
MICROPHOTOGRAPH OF FIBRES TAKEN IN ORDINARY LIGHT.

What appears to be the earliest known European paper document in Germany is a letter to the town of Aix-la-Chapelle, and kept in the archives of that town. It is dated A.D. 1302.

We find some quaint remarks, by Fuller, about the papers of his time (A.D. 1608-61) which, we think, may aptly be quoted here. He says: "Paper partakes, in some sort, of the characteristics of the country which makes it—the Venetian being neat, subtle, and court-like; the French, light, slight, and slender; and the Dutch, thick, corpulent, and gross, sucking up the ink, with the sponginess thereof."

The collection of German papers to which we are about to refer numbers between two and three thousand different papers, dating from 1352. With one or two exceptions, there are no duplicates. They may be taken as being representative of papers used at these different periods, not only in Germany, but also in England. They are fairly uniformly distributed as regards date, but are particularly numerous in Elizabethan times. The Elizabethan papers number 459, many years being represented by 15 to 20 papers; with a few breaks all years are represented up to about A.D. 1850. The textures and water-marks of about 1,000 have been photographically reproduced.

FIG. 4.



MICROPHOTOGRAPH OF FIBRES TAKEN IN POLARISED LIGHT.

The Table printed at the end of this paper shows the results of a microscopical examination of a number of representative papers selected from the collection. Information in regard to the character of the marks, the sources from which they are derived, &c., can be got by reference to recent publications, in which, in all, about 100 of the more important water-marks have been repro-

duced from the photographs above-mentioned.* One thing to be noted about this collection is that all these papers right away from A.D. 1352 to 1730 appear to consist entirely of flax or linen rags, after which cotton comes in, admixtured with linen rags.

Although the papers are chiefly of German origin they may be taken as typical of this country also, because no doubt up to the time of Elizabeth nearly all the paper was of foreign origin, probably chiefly German, and even up to the end of Charles II.'s reign, as one of us has proved, Court papers were made in Germany. It appears also that at the time of the Georges a large amount of the paper used here came from that source also. We have, we think, sufficient evidence to show that the manufacture of hand.made paper underwent very gradual changes, and that the thirteenth and fourteenth century papers, to judge from the few specimens that are available, were distinctly inferior as regards texture and felting qualities, although perhaps superior from point of composition to those which came later. All the papers we have examined microscopically, about 50 in number, ranging from A.D. 1212 to 1750, whether from Northern Germany or from the South of France or Spain are made of flax or linen rags. After about 1750 cotton rags were found in the papers we have examined.

Most of these early papers show the laid-mark. The A.D. 1352 paper has about 9 marks to the inch with a distance of 1½ inches between the chain-marks. The A.D. 1386 paper has the same laid-marks as the foregoing with the water-mark of a negress's head. Both papers are well preserved. Exactly the same character and texture of mark is to be found in papers up to A.D. 1415.

Another thing which appears to distinguish German paper of the thirteenth and fourteenth centuries from those of later date is their greater thickness as well as their greater variation of thickness in different parts of the sheet. About A.D. 1535 we get a change to a thinner paper with much closer and finer laid-marks (24 to the inch), the distance between the chain-marks being also closer, although somewhat irregular. There is, as in paper of A.D. 1526, evidence of very rough workmanship in the chain-marks of the wire cover of the mould, but good texture of paper and careful beating and cleansing of raw material. The character of the surface would compare even favourably with many hand-made papers of the present day. There was evidently some fault in the construction of the paper moulds of early days which caused the fibres to heap up on either side of the chain-marks, rather spoiling the general appearance of the paper when looked through. This, in modern moulds is avoided. Occasionally specks and lumps are found, as in the paper of A.D. 1580, owing to the fact that they did not use strainers for the pulp. Such papers show the felt-marks as of some coarse felt having been used for couching the sheets. Although some of these papers are no longer impervious to ink, they appear to have been quite satisfactory at the time they were used for documents.

The more carefully prepared papers of the sixteenth century, especially those which were properly cleansed in the manufacture, show no sign whatever of discolouration when properly preserved.

At all periods with the exception of the thirteenth and fourteenth centuries, when the papers seem to be more or less alike, we notice some good and some bad papers, some carefully beaten and made, others of a bad colour from unbleached material containing the flax straw, and carelessly made. When not properly cleansed the papers appear to have undergone deterioration, even though carefully preserved, as in a paper of A.D. 1617, a Brunswick paper bearing the water-mark of an antler; the deterioration is sufficient to produce discolouration or spottiness, but without appreciable diminution in strength. Our opinion, therefore, is that a paper, even if made of flax, requires to be properly cleansed if it is to preserve its colour as well as its strength, even when properly stored away from light and moisture. Bad storage may lead to the destruction of even the best papers.

At times it is possible to distinguish between discolouration and dirt, as with a paper of A.D. 1609. It is very rare even at this period to meet with papers made from material "beaten to work wet." Many of the thirteenth and fourteenth century papers are soft and spongy, not unlike a thin drugget. It would surprise a paper-maker of to-day to hear that such papers are made from flax, because he utilises flax o-

* Photographic reproductions of different papers in the collection, together with descriptions of same, have appeared in the following journals:—"The Paper-maker" (special annual number), 1907, vol. xxxiv.; "The Paper Trade Review," April 3, 1908, vol. xlix.; No. 14, "Paper-making," April, 1908, vol. xxvii.; No. 4, "The Paper-makers' Monthly Journal," April 15, 1908; "Pulp and Paper Magazine" of Canada, March, 1908, vol. 6; No. 3, "Der Papier Fabrikant," March, 1908; No. 12, vol. vi.

rather linen and rags in the production of hard, strong papers, such as vellums. This property of the flax fibres does not appear to have been known to these early paper-makers, and no doubt it must have been very difficult to produce wet working material with their crude appliances, and from that form of materials. It looks as though they used flax in distinction to linen rags. Even up to the beginning of the nineteenth century few of the papers out of the 2,500 we have examined have a linen feel about them. Here and there some are a little harder than others, probably owing to accident, but this quality of the linen fibre was evidently not known or it would have been utilised to a greater extent to produce papers more nearly resembling vellum.

In the middle of the seventeenth century some mills must have employed a high-class material, the colour of the paper even to-day being almost equal to the bleached material now used for hand-made paper. In such papers the laid-marks were very fine and close together (30 to the inch) three-quarters of an inch apart, with the chain-marks extremely fine and close. Such fine marks are not used at the present time, and must have given some difficulty, there being a tendency during chouching for the marks to become obliterated.

The general run of the papers during the early part of the eighteenth century appears to have been of a thicker and coarser description. The chain-marks were clumsily put on, further apart, and the mould not so carefully prepared. Paper seems to have reached its greatest degree of excellence in the time of Charles II. This we judge not only from the collection we have examined, but also from papers sent us from other sources, notably the Court papers in Charles II.'s time, which for cleanliness, felting qualities, and general texture would compare favourably with hand-made papers of the present day. In regard to the care displayed in the construction of the water-mark, its fineness and artistic merit, we think this paper equals anything we have seen now used for trade purposes. We wish to emphasise this because water-marking as now employed is thought by the paper-makers to be an improvement on the methods of their forefathers. Unfortunately the paper above referred to has been identified by one of us as having been made in Germany. We cannot, therefore, claim that the excellence of this period applies to this country.

About the time of Charles II. the paper-makers themselves must have been very skilled and also the mould-makers and those who prepared the water-marks. The eighteenth century papers appear to have been made at a time when paper came more extensively into use, and was made in a more wholesale manner; but although some of the water-marks are very elaborate and very well executed, at times they are very inferior and of inartistic design; the extremely rough nature of the chain-marks spoils the general appearance of the sheet, and detracts from any merit that the water-mark may have, as, *e.g.*, in a paper, date A.D. 1718, in which the water-mark consists of a crowned "CC," Grand Duke Carl. Most of these papers of this period are of a brownish colour, owing probably to their having been prepared from an unbleached flax containing at the same time a good deal of flax straw.

At this time also we find in some papers thicker lines running at right angles to the chain-mark, about one inch apart, thus dividing the paper into squares, as illustrated in a paper of A.D. 1793, with a water-mark of "I. C. F." and swan in crowned shield.

Through the courtesy of Sir Albert Spicer, we are able to show on the screen diagrams illustrating important economic changes and developments in the paper trade of this country and Germany during the last hundred years. A more detailed account of these will be found in Mr. A. Dykes Spicer's book, "The Paper Trade" whence the diagrams in question are derived, and to which all who wish to study the economic side of the question are referred.

It is refreshing to find, at the end of the eighteenth century, the policies of leading Continental insurance companies printed on paper made in this country, which paper without doubt does this country credit. The names of one or two of the leading firms in this country have been held in high esteem on the Continent, and are still so held, both as makers for hand-made and machine-made papers. This has given rise at times to numerous frauds. We have, for instance, collections of English-made papers from Continental sources bearing the marks of well-known makers. We submitted about one dozen Whatman papers, collected on the Continent at different dates, to Messrs. R. and W. Balston, the present makers of the famous Whatman papers; we had a suspicion that they were not all of their manufacture; it turned out that half of them were Continental imitations. The productions of two other Kentish mills have also been repeatedly imitated on the Continent. Thus, paper is, or was, made in Austria in an

unblushing manner, and imported into our Colonies bearing the mark of well-known English firms. In all the cases we have examined, the imitation product is very inferior to the real article. No doubt the Continental firms produce a finer water-mark than the English, but for strength, durability, and sterling qualities, the English product is unrivalled.

The very best appearance and clearness of mark cannot be got with the strongest and most wearable paper. One can only be got somewhat at the expense of the other. The English makers recognise this, and produce the best all-round paper.

Thus, in spite of the fact that we got all paper up to the Elizabethan time from abroad, and for a long time after the best of our papers, England eventually came to the fore in the very highest class, and is at present leading as regards quality and excellence, although in some special lines Italy may be said to be superior. It reached that state of perfection during the Victorian era. It was then that the cheaper machine-made paper came into competition. This latter was also brought to a high degree of excellence, so much so that it threatened the makers of hand-made paper. Hand-made paper must stand or fall on its high quality.

APPENDIX.

Examination of MSS. Papers taken from Clayton Beadle's Collection of Water-marked Papers.

Catalogue No.	Date A.D.	Thickness. Maximum in mm.	Minimum in mm.	Mean of all measurements.	Microscopical examination made by authors after treatment by Schutz sol. or Chlor. zinc iodide.	Reputed place where MSS. found.	Water-mark.
111	1352	·28	·22	·237	Clean long flax fibres (possibly some few hemp fibres).	—	—
1426	1386	·29	·24	·262	Clean long fibres, well preserved.	Brunswick.	Negress's head.
1793	1415	·29	·26	·272	Flax fibres, long, coarse, but clean and slightly coloured.	Brunswick.	Arms of Regenborg.
545	1425	·27	·21	·245	All clean flax fibres, fine and long.	—	Arms of Bishopric of Eichstadt.
1562	1478	—	—	—	Flax finely beaten, disintegrated portion coloured blue.	Brunswick.	Ox's head, with pole and flower above, and pole and cross below.
820	1536	·19	·17	·180	—	Lübeck.	Open hand, with crown.
326	1583	—	—	—	Flax fibres, beaten short with hairy outgrowths.	Brunswick.	Four-field coat of arms.
1576	1535	·22	·19	·202	—	Brunswick.	Ox's head, with serpent round long cross.
325	1589	—	—	—	Clean, well-beaten flax fibres, not coloured; many fine and short.	Brunswick.	Four-field coat of arms with "A B."
747	1537	—	—	—	—	—	Fish, probably pike.
821	1538	·24	·17	·178	Flax fibres — much foreign matter as though some growth had developed—ends clean cut; fibrillæ.	Copenhagen.	Open hand, with crown.
1573	1580	—	—	—	Flax, long fibres, not bruised; clean cut. Uniform coloration.	Brunswick or Spier.	Ox's head, with antler on pole.
392	1552	·24	·18	·172	Flax, with possibly a few cotton fibres; fibrillæ.	—	Climbing bear.
1657	1597	—	—	—	Flax fibres, coloured only at cross markings. Apparently diseased, due to insufficient cleansing.	Brunswick.	Prancing horse.
839	1553	·20	·24	·222	—	Brunswick.	Foolscap with two tassels

APPENDIX (*continued*).

Catalogue No.	Date A.D.	Thickness. Maximum in mm.	Minimum in mm.	Mean of all measurements.	Microscopical examination made by authors after treatment by Schutz sol. or Chlor. zinc iodide.	Reputed place where MSS. found.	Water-mark.
163	1564	—	—	—	Flax coarse fibres, coloured, uncleaned, or partially diseased.	Brunswick.	Arms of Brunswick.
1581	1566	·26	·19	·277	—	Brunswick.	Crowned ox with cross in shield on forehead.
2273	1596	·20	·17	·190	Flax fibres long, not bruised, few fibrillæ and flax straw.	Brunswick.	Lion in decorated shield.
1133	1605	—	—	—	Clean flax long fibres, and a few hairy outgrowths.	—	Two towers with "E S" below.
2132	1606	—	—	—	Flax fibres, much reduced in length. Coloured at cross markings — no fibrillæ. Apparently imperfectly cleaned before manufacture.	Brunswick.	Crowned four field of arms of Wurtemberg
2316	1607	·17	·17	·155	All flax fibres clean, well beaten, and in good condition.	Brunswick.	Antler in double circle.
1896	1615	·16	·14	·150	—	Bremen.	The Caduceus with two flowers on shield.
2319	1620	·20	·15	·192	All flax, frayed at edges, clean fine long fibres.	Brunswick.	Plant on a heart and lion in double circle.
2334	1623	—	—	—	—	—	"R" in crowned shield.
1696	1624	·17	·15	·165	—	Wolfenbuttel.	Arms of Ponickau.
295	1626	—	—	—	—	—	Crowned "C i C" Grand Duke Carl.
2224	1631	·17	·15	·162	—	—	Coat of arms with clover plant.
2240	1637	·16	·14	·150	All flax fibres, some much beaten, dirty, or covered with growth. (Trace of cotton ?)	—	Crossed axes in crowned shield.
2295	1649	—	—	—	Flax fibres, fine, and fairly clean, rather reduced in length.	Brunswick.	Quartered shield with posthorns and two eagles.
172	1650	—	—	—	—	Silesia.	Arms of Breslau.
1265	1651	·15	·13	·140	—	Brunswick.	Jug with flowers.
938	1665	·19	·13	·155	—	—	Stag walking.
355	1666	—	—	—	Flax fibres, long, and very little beaten, not coloured.	Brunswick.	Foolscap with tassels.
1649	1669	·22	·17	·190	—	Brunswick.	Horse in circle with a clover leaf.
529	1676	—	—	—	—	Helmstedt.	Pine trees with "M F."
1815	1678	·15	·13	·145	Flax fibres, clean but very much beaten.	Brunswick.	Crown and posthorn. Rellichausen, a paper mill in Eimbeck.
1130	1684	·15	·12	·130	—	Halberstadt.	Two towers with horn below.
1399	1684	·17	·14	·155	—	—	Arms of Mansfield.
2393	1684	·13	·11	·123	Fairly long clean fibres.	—	Posthorn in shield.
645	1689	·24	·22	·222	—	—	Griffin.
2252	1693	·19	·15	·170	—	—	Head of a dog in a shield.
1490	1695	·17	·14	·157	—	Amsterdam.	Arms of Holland.
227	1696	·23	·19	·212	Flax fibre fibrillæ—fair length of fibres. Material apparently not properly cleaned. Fibres coloured in places only.	Brunswick.	Bergstadt. Arms of Bernburg.

APPENDIX (*continued*).

Catalogue No.	Date A.D.	Thickness. Maximum in mm.	Minimum in mm.	Mean of all measurements.	Microscopical examination made by authors after treatment by Schutz sol. or Chlor. zinc iodide.	Reputed place where MSS. found.	Water-mark.
1140	1719	—	—	—	—	Brunswick.	Two towers, with horn below.
925	1726	·20	·13	·165	Flax, or linen rags well beaten.	Pomerania.	The virgin and child, in half moon.
1395	1730	—	—	—	Flax and fibrillæ, somewhat impure.	Brunswick.	Male figure wearing sword.
2344	1733	·23	·21	·224	Linen and cotton well beaten, but fibres not bruised as in modern papers.	—	"ICF" and swan in shield.
91	1743	—	—	—	Flax or linen rags with apparent trace of cotton.	Brunswick.	Arms of Asseburg.
2358	1750	·22	·15	·192	—	—	Wolf in crowned shield.
230	1765	·20	·17	·190	—	—	Arms of Bernburg and monogram of Victor Amadeus I.
920	1768	·17	·15	·157	—	Brunswick.	The Virgin and Child.
2034	1773	·22	·17	·190	—	—	"I C S M" and fir tree.
93	1773	—	—	—	All flax or linen, fibre clean, beaten fine.	Glücksburg.	Arms of Asseburg in star.
79	1776	·16	·13	·150	—	—	Anchor.
93	1778	·23	·17	·195	—	Glücksburg.	Arms of Asseburg in star.
1847	1788	·21	·17	·182	—	—	Crowned Saxon arms.
1765	1790	·16	·14	·155	Linen rags, some cotton.	—	"T W R" under crown Prussia.
2179	1793	—	—	—	Flax or linen rags, coarse and fine, and detritus of fibres and starch.	Hamburg.	"X" and "D and C" in shield, with tree on top.
2127	1795	·25	·14	·177	—	—	Prussian eagle and "Wischwill."
725	1796	·20	·15	·177	—	—	Arms of Von Gaten with "C W."
488	1797	·17	·15	·158	—	—	Crowned Prussian eagle.
2382	1797	·21	·18	·192	Cotton and linen rags.	—	Coat of Arms.
1725	1799	·21	·19	·197	Linen and cotton rags.	—	"Portal and Bridges" with "1794."
292	1800	·21	·19	·200	—	—	Crowned "C C," Grand Duke Carl.
304	1800	—	—	—	—	—	Do.
1398	1801	·20	·14	·182	—	—	Male figure and "I P."
1737	1805	—	—	—	—	—	Flying Prussian eagle.
2078	1807	·20	·16	·177	Flax or linen fibres; fair length, coloured in parts. Fibres appear as though covered with some vegetable growth.	—	Crown and portrait of Napoleon.

DISCUSSION.

The CHAIRMAN (Mr. Carmichael Thomas), in opening the discussion, said the Royal Society of Arts had always taken a great interest in the question of paper, and there was now in existence a committee of the Society dealing with the subject of its deterioration. Personally, he thought it would be a great advantage to our descendants if most of the paper on which current literature was printed was destroyed by the power of time, but there were some publications which it would be a benefit to our descendants to preserve, among them being the proceedings of the Royal Society of Arts. The authors had given many interesting facts in tracing the manufacture of paper from the Chinese to the Arabs, until it entered Europe by the help of the Moors When it did reach Europe it was-

found that, as usual, England was quite behindhand in the matter. All the paper in the time of Queen Elizabeth seemed to have come from abroad, but he was glad to see from the last paragraphs of the paper that this country was now quite at the top of the tree, and well able to hold its own. This country was very slow in taking up anything fresh, but it usually came to the top at last. This made one feel quite hopeful for the British aeroplane. Among the many materials of which paper was made, the authors had not mentioned mummy cloths, from which it was sometimes said that paper was made. He had read of an Arabian physician travelling in Egypt in 1200 who described how paper was made from those articles. The first English patents for paper-making were taken out in 1665, and if anyone took the trouble to look through the list of materials which had been used in the manufacture of paper since that date, it would be found to comprise a most curious collection, including bean-stalks, clover, dung, hops, leather, nettles, sawdust, seaweed, and bananas. The author mentioned the letter from the Count of Toulouse, dated 1216, now in the Public Record Office, as the earliest known paper in this country, and probably Mr. Beadle knew of the specimen at the monastery of Goss, in Styria, dated 1242, which was supposed by some to be the earliest example of paper made from rags in Europe.

Mr. John Christie inquired whether the authors knew if any examination had been made of the Chinese papers which were supposed to date back 2,000 years? It was stated in the paper that Wiesner had examined papers of as early date as the fourth or fifth century of this era, and it was quite possible that, among the archives of the Chinese kingdom, other records might be in existence, because Wiesner expressed a wonder as to how they were made. Had the authors made any investigation to ascertain whether such papers existed in Pekin or elsewhere? He quite endorsed the remarks the Chairman had made as to the desirability of the majority of the literature of the present day perishing; and he understood that most of the mechanical wood pulp paper books comprising the cheaper form of present-day literature that were on the shelves at the Bibliographie Nationale would certainly be dust, if not ashes, in about sixty years. It seemed to him it was a waste of national space if books were preserved when, to the certain knowledge of scientists, like the author, within two generations at least the paper would be reduced to dust; and he therefore thought it ought to be incumbent by Act of Parliament on every printer of a book, or newspaper, from *The Times* downwards, to print a few copies on good rag paper, for preservation in the National records. When he inspected the Record Office Library, Sir Maxwell Lyte complained to him that, even in the dry library at the Record Office, the paper of a very fine book, printed in France, was rapidly perishing, although it was only twenty years old. He thought it would be a great step in advance if, for instance, the Council of the Royal Society of Arts suggested that an enactment of the kind he had proposed should be passed. There was no reason why present day paper-makers should not be able to produce a rag paper which would last as long as the famous 1217 paper of the Duke of Narbonne, containing a mandate to David, the linen draper, of London.

Mr. W. A. T. Foster, a maker of hand-made paper, thought the reason why so many water-marks appeared in the folio edition of Shakespeare, to which the authors had referred, was that in the early days it took a long time to make hand-made paper, and that might account for a great number of paper mills being employed in producing the article, each using a different water-mark. Even to-day, with the most up-to-date process for making hand-made paper, each sheet of paper had to pass through fifteen or sixteen pairs of hands before it was a finished production, and it was therefore natural to suppose that in the early days with more primitive methods a much longer time was taken. He believed that in those days hand-made paper had to be dried by air, which was more suitable in some countries than in others, but certainly the drying of paper alone took two or three days in the water leaf stage. After it was sized three or four days had to elapse for drying purposes, following which there was the process of finishing, which also took a considerable time. Better methods of drying paper had now been introduced, so that it could be produced much more quickly. He did not think there was a single mill in the kingdom which used anything but rags for their hand-made papers, the various qualities, such as cotton and linen, being carefully manipulated so as to bring forth what was considered to be the strongest and most durable paper that could be made. As the author had explained, the reason very largely of the durability of hand-made paper was that it was allowed to shrink. It was put up to dry; there was no uneven stretching of the paper, and it was allowed to shrink back upon itself, which, in a machine-made paper, was impossible. Hand-made paper makers therefore claimed to-day that hand-made paper would last for centuries, so that it would be as good 100 or 200 years hence as it was at the present time.

Mr. Clayton Beadle, in reply, said it was interesting to hear from the Chairman that the first patent taken out in this country was in 1665, which was very close on the time that the improvement in the manufacture of hand-made paper took place. That improvement seemed to have resulted from the enlightenment which was thus brought to bear on the subject, which largely came from abroad. The earliest dates of European papers of authentic date were, he thought, those mentioned as being contained in the Escurial, both linen and cotton papers. He agreed with Mr. Christie that it would be extremely

interesting if earlier papers could be unearthed. There was a mention of discoveries by Dr. Stein of papers in the Desert of Turkestan. Those were some of the very earliest papers, but they did not go back anything like so far as historical records stated were the beginning of paper-making. Possibly paper was made quite independently of the Chinese. The Aztecs and the Maoris were said to have made a primitive paper, and possibly they and other nations independently discovered the manufacture of paper, although the antiquity of their discoveries was not known. He agreed with the suggestion Mr. Christie made, that all papers and books which were forwarded to the British Museum and the Bodleian Library, which it was intended should be kept for any length of time, should be printed as a sort of Edition de Luxe, a few copies being printed on special paper of lasting quality. That might be made compulsory by Act of Parliament, and it would be a comparatively simple law to comply with. Mr. Foster had suggested that the length of time it took to make hand-made paper had something to do with the fact that so many papers with different water-marks were found in one folio edition of Shakespeare. Probably that necessitated the makers agreeing upon uniformity of size, substance, and colour, to which he had referred, and this history seemed to confirm. If a number of mills had to produce paper for a particular publication there must be no irregularity in the sheets made.

The CHAIRMAN said he would have much pleasure in bringing the suggestion Mr. Christie made before the notice of the Council of the Society. He was not at all sure, however, that the authorities of the British Museum were not rather reckoning upon all papers being destroyed in sixty years, because if they were not, they would probably require a building from Oxford-street to King's-cross to store them all in. He desired, in conclusion, to propose a hearty vote of thanks to Mr. Clayton Beadle for the interesting paper he had read, and also to associate with the motion the name of Mr. Henry P. Stevens, who had considerably helped in its production, but who was unable to be present.

The resolution of thanks having been carried unanimously, the meeting terminated.

UNIVERSITY EDUCATION IN LONDON. ROYAL COMMISSION.

The King has been pleased to appoint a Royal Commission on the subject of University Education in London.

The terms of the reference are:—To inquire into the working of the present organisation of the University of London, and into other facilities for advanced education (general, professional, and technical) existing in London for persons of either sex above secondary school age; to consider what provision should exist in the Metropolis for University teaching and research; to make recommendations as to the relations which should in consequence subsist between the University of London, its incorporated Colleges, the Imperial College of Science and Technology, the other Schools of the University, and the various public institutions and bodies concerned; and further to recommend as to any changes of constitution and organisation which appear desirable. In considering these matters regard should also be had to the facilities for education and research which the Metropolis should afford for specialist and advanced students in connection with the provision existing in other parts of the United Kingdom and of his Majesty's Dominions beyond the seas.

The Chairman of the Commission is the Right Hon. R. B. Haldane, K.C., M.P., and the members are—The Right Hon. Viscount Milner, G.C.B., G.C.M.G., the Right Hon. Sir Robert Romer, G.C.B., Sir Robert L. Morant, K.C.B., Mr. Laurence Currie, M.A., Mr. W. S. M'Cormick, M.A., LL.D., Mr. E. B. Sargant, M.A., and Mrs. Creighton. The Joint Secretaries to the Commission are Mr. J. Kemp and Mr. H. F. Heath.

Although it is little more than ten years since the last Royal Commission reported on the University of London, it has for some time been becoming more and more evident that the constitution of the Senate as settled by the University of London Act, 1898, is far from satisfactory. The University problem in London is one of extraordinary difficulty and complexity. Founded in 1836, the University at first admitted to its examinations only those who had been educated at certain specified colleges, but the standard required for admission as an affiliated institution gradually sank so low that in 1858 the examinations (except in the case of the Faculty of Medicine) were thrown open to anyone, wherever or howsoever educated. Up till 1900 the University of London was purely an examining body. As such there can be no doubt that it did its work efficiently. The standards of the examinations, especially in the faculty of medicine, were high, and an opportunity of obtaining degrees was afforded to many who were debarred by poverty or other causes from college life. But, while most people were agreed that the University, as thus constituted, was discharging a honourable and useful function, it was felt by many, particularly among those who represented the academic life of London, that it was a standing reproach to the greatest city in the world that she should possess no teaching university. This feeling resulted in the reconstitution of the University in 1900, when an attempt was made to devise a machine whereby on the one hand the old examining system should be continued, while on the other an academic side should be developed. The students were divided into two classes, internal and external. The latter

were those who simply presented themselves for examination, as under the old *régime*. Internal students, on the contrary, were required to be registered as such and to have pursued approved courses of study under teachers recognised by the University before they were eligible to enter for the internal examinations.

There can be no doubt that the establishment of an internal side has done a great service in stimulating academic life in London. It is scarcely too much to say that ten years ago such life was languishing, if not moribund. To-day there are 3,800 registered internal students, 843 recognised teachers, and 59 schools and institutions to which recognised teachers are attached. Steps have also been taken to encourage research, and there are now considerable numbers (including many graduates of other British and foreign universities) who are working as internal students for higher degrees. Intercollegiate courses of an advanced nature have been organised, and there is now scarcely any branch of academic work in which the University does not provide facilities for undergraduate or post-graduate study.

But all this has been done in spite of grave difficulties. The Senate has been practically divided into two parties, the one representing the internal interest, *i.e.*, the professorial party, and the other representing the old external students. The latter were justly proud of the reputation enjoyed by the unreformed University, and not a few of them were persuaded that a system in which teachers took a share in the examinations would entail a lowering in the standard of the degrees. The result of this conflict of interests has been that the Senate has had no settled or continuous policy, and in connection with the problem of medical education at least one disastrous *volte-face* has been executed.

The situation, already difficult enough, became further complicated when in 1907 the Imperial College of Science and Technology received its charter of incorporation. True, it was established in the first instance as a school of the university, but this really meant little more than that a student of the Imperial College can take an internal degree. The Governing Body of the Imperial College is practically autonomous, and is so powerful that the Senate, as at present constituted, cannot hope to impose conditions upon it. Nothing short of a Royal Commission would have had the authority to define the relations which are to subsist between these two bodies, and as it had to be, it is as well that there has been so little delay.

The Commission propose to get to work almost immediately, and it has been stated that it will be at least a year before it can report. A glance at the terms of reference will show that the Commissioners will have to sit very long and very frequently if their work is to be completed in that period. The task is enormous. To take a single item, nothing more surprises the foreign student than the exiguity of the Law School in the University of London. In the city that boasts the greatest law courts in the world the University is hard put to it to find teachers to cover the laws curriculum. Of course, there are plenty o opportunities of studying law in London, but not under the ægis of the University. When is it remembered that this is only one of very many important questions that might well come within the terms of reference, some idea will be gained of the vastness of the work that lies before the Commissioners. Interpreted in the narrowest spirit, their labour is no light one, and their report will be eagerly awaited by all who are interested in University education, not only in London, but throughout the British Empire.

THE THORNEY ESTATE.

The statement that the Thorney Estate of the Duke of Bedford is shortly coming into the market recalls one of the most interesting and boldest experiments in land reclamation ever attempted and successfully carried through in this country. The great Bedford Level, which comprises upwards of 30,000 acres, and extends into six counties, with its principal area in Cambridgeshire, is the largest tract of fenland in the kingdom. The whole surface of the fens in which the Thorney Estate is situated is lower than the sea, the level being 9 feet to 12 feet below high water mark in the German Ocean. The difficulty of draining this tract was increased by the circumstance that the ground is higher near the shore, and falls inland near the foot of the slope. The Fen country had been reclaimed from the sea long before the days of the Bedford Level, but by the end of the sixteenth century the drainage works of the Romans, which had been maintained and carried on by the monks, had fallen out of repair, and land which previously was remarkable for its fertility was once more submerged. The district is naturally drained by the Ouse, the Witham, the Welland, and the Neve. It was only on the maps that these rivers ran into the sea. At the time when Francis, fourth Earl of Bedford, began to devote his attention, capital, and reputation to the task of recovering the land to its original purpose of growing corn, "the river beds," to quote the present Duke of Bedford in "A Great Agricultural Estate"—to which interesting volume this article is indebted for its facts—"were foul, the channels choked, the streams continually overflowed their banks, twice a day the tides drove back the fresh water and prevented the discharge of the upland streams." The country which Francis, Earl of Bedford, took in hand in the year 1650, in company with thirteen gentlemen adventurers, had thus become one vast deep fen, "affording little benefit to the realm other than fish and fowl, and overmuch harbour to a rude and almost barbarous sort of lazy and beggarly people." The Earl of Bedford owned 20,000 acres

round Thorney and Whittlesea of this fenny level. In 1629 a Session of Sewers imposed a drainage tax of 6s. per acre, but no part of this tax was ever paid. In 1630 another session met, with the famous Dutchman, Sir Cornelius Vermuyden, at their elbow, "but the country not approving of him, as being a foreigner, and not liking to contract with aliens," they intimated their dislike to the Commissioners and became suitors to the Earl of Bedford to undertake the work of reclamation, and this "he condescended" to do.

With this application and consent the real work began. In three years the whole level was declared to be drained, and within this space of time the Earl of Bedford and his participants had spent no less than £100,000, equal perhaps to £300,000 at present. All the participants were completely ruined and the Earl's circumstances much reduced. It was an age of intrigue, and the 95,000 acres promised to the Earl were withheld on the plea that the work of drainage had not been properly done, and the King was declared "undertaker." Then came the Civil War, and in 1649 William, Earl of Bedford, son and heir to Francis, was declared to be "undertaker," and was to have 95,000 acres for perfecting the work. Earl William resided at Thorney in order to superintend the work, and from 1663 to 1685 devoted his energies to the often ungrateful task of reclamation. It is not clear what he actually received for his strenuous undertaking, but Dugdale mentions the fact that Earl Francis was owner of 20,000 acres around Thorney before the reclamation. From that time until now the head of the House of Russell has held about 20,000 acres at Thorney, but he has never got much out of it in the way of net profit.

In "A Great Commercial Estate," the present Duke of Bedford gives the income of the estate from 1816 to 1895. The total income for that period he puts down at £2,282,562. Against this, £599,607 went in taxation, £382,873 in repairs and maintenance, £265,155 in new works and permanent improvements, £350,178 in other expenditure (including management), leaving a net income of £684,209, the percentage of net income to gross income being 30½, and the average annual net income £8,552.

Writing in 1897, the Duke of Bedford said, "low prices, bad seasons, and a crushing weight of taxation have entirely caused rent, as understood by the political economist, to disappear from the Thorney estate. At the same time, the average net income for the past twenty years (even without taking the death duties into account), is only equal to 2 1-7th per cent. interest on the capital outlay on new works." The Duke adds, "the commercial instinct would have suggested abandonment of Thorney in despair in 1880, and would have severed the ties which have bound my family to the old Walloris settlers of the seventeenth century." His Grace goes on to say that "as to the pleasures to be derived from the ownership of an estate like Thorney, if the reader conjures up a beautiful mansion and park with endless game preserves, he is mistaken. They do not exist. The only pleasure which I and my forebears can have derived from Thorney is the kindly feeling – there has never been an eviction of a farm tenant on the Thorney Estate—which has existed between us and our tenants and the inhabitants of Thorney town." The good feeling of which the Duke of Bedford speaks has remained unbroken and unaffected until now, when it is illustrated even by the Duke's refusal to accept offers that have been made to him to dispose of the land privately, preferring that the property should be put up for public competition, and so give the tenants a chance of acquiring their own holdings.

AFFORESTATION AND EMPLOYMENT

In the course of a paper on "Forestry in some of its Economic Aspects," read before the Royal Statistical Society, Professor W. Somerville raised the question: "How many men can find constant employment per unit of area—say, 1,000 acres—in a forest worked upon a definite rotation?" The answer, he says, "will obviously depend upon various considerations: —The species of tree, the length of the rotation, the character of the ground, the method of working—whether stocking is accomplished by natural or artificial means, and if the latter, whether by sowing or planting—whether the trees are sold standing or are first felled, whether the timber is disposed of 'in the rough' or is partially converted, and so on. The census reports for 1901 show that 16,395 persons in the United Kingdom were returned as woodmen, and if this figure be used as a divisor for the number of acres under wood, 3,075,773, we get 187 as the number of acres allotted to each man. But, interesting as this figure is, it is obvious that it cannot be applied to our present purpose. A very large proportion of our wooded area is held in such small portions—say under 50 acres—that the owner does not keep a woodman, while in the underwood districts o England—chiefly the south-east—the woods are ofte let to the agricultural tenants, who do the cuttin with ordinary farm labour. One gets a better idea c the labour that land under wood can absorb, b ascertaining the number of the forest staff on estate with a large area of woodland. But in this countr even this method of inquiry will yield a figure that not quite satisfactory, inasmuch as the growing stoc of timber in our woodlands is almost invariably low than it would be under good management, and co sequently the staff required is also somewhat belc normal.

"The most reliable data as regards labour are u doubtedly furnished by the great State forests France and Germany, and there it is found tt forest work, up to and including the felling of t timber, requires the services or provides the remune tion of one man to 75 to 100 acres. If these figu be adopted, as they have been adopted in recent

quiries,* it means that pastoral land converted to sylviculture can maintain a population ten to thirteen times as dense as that which formerly occupied the ground. And this, of course, takes no account of the further labour that is required for hauling the timber, and for manipulating it in the sawmill, pulp factory, or elsewhere.

"I have indicated what is, approximately, the density of the population that forest land can permanently maintain; but, where the forests are first to create, a more immediate question is: What amount of labour will be required during the stage of sowing and planting? The answer to this question also depends on a variety of circumstances—the kind of ground, the species of tree, the size of plant, the method of planting, and others—but, taking a broad average, it is probable that the afforestation of 100 acres will require the services of twelve men during six months. While the general operations of forestry extend throughout the year, the actual work of planting is confined to the period between the middle of October and the middle of March. This is the time of year when labour is most abundant, and it is also the time when work on farms is least pressing. Forestry, therefore, fits in well with our rural social conditions. While the Royal Commission fail to see in afforestation any solution for the problem of unemployment, they point out that it is better fitted than any rural industry to retain population on the land, while it also harmonises well with the development of small holdings. On the Continent most of the winter work in the forests is performed by men who, during summer, are engaged in agricultural operations, generally on their own holdings. It was given in evidence that in Scotland crofters found it an immense advantage to have woods in their neighbourhood, in which they could find remunerative employment at a time when they could be readily spared from their holdings."

* "Report of Royal Commission," Sect. 62–65. "Report of Committee" of 1902, Sect. 9.

LIFE IN TAHITI.

Of the total population of the Society Islands and dependencies, composing the French colony of Tahiti, numbering 31,000, more than 27,000 are of the native race, a fine type of Polynesians; about 2,200 are French, and about 1,500 are of fourteen other nationalities, mainly, British, Chinese, and American, ranking numerically in the order named. Nearly two-thirds of the population live in the Society Islands, the group most advanced in civilisation. Notwithstanding the fact that the hundred islands comprising the colony are scattered over an area of the South Seas extending 1,300 miles from north to south, and 1,600 miles from east to west, the inhabitants of most of them have had more or less contact with civilised people for a century. Various denominations have churches in the principal settlements in the larger islands. The United States Consul in Tahiti says that the town of Papiti, which is the seat of the colonial Government and the commercial centre of the colony, has a population of nearly 4,000. Here are large wholesale and retail stores, two banks, several hotels, four schools, five churches, a free library of French books, a good hospital, a philharmonic society, two social clubs, a chamber of commerce, a telephone system, and a semaphore station. The water system is plentifully supplied from a pure mountain stream. The market, which is under the supervision of a food inspector, is supplied with an abundance of fresh meats and a great variety of fish, vegetables and fruits. Bicycles are common, and there are a few automobiles, for which the good roads, kept up by the Government, are well adapted. There are letter carriers in the town, and a delivery of letters throughout the island of Tahiti daily. Besides the Government establishment there are three other small printing offices in Papiti. With the exception of the small sheets published by the missionaries, there is only one paper published, the official journal, which is devoted mainly to official matters and announcements of all kinds. The climate of Tahiti, though warm, is healthful. The mercury seldom goes higher than 90 degrees, or lower than 65 degrees Fahrenheit, except in the mountains, which rise to the height of about 7,000 feet. Owing to transport rates and custom duties, almost all imported articles of food, including flour, bacon, lard, and tinned meats, salmon, butter, vegetables and fruit, are somewhat expensive. Fish, though plentiful in the sea, is dear in the market. Vegetables, grown by Chinamen, are cheap, and so are fruits, which grow almost without cultivation.

HOME INDUSTRIES.

Unemployment: Labour Exchanges.—Differing in much, the two reports of the Poor-law Commission agree that unemployment, particularly in the form of casual, intermittent, or under-employed labour, is the most serious cause of permanent pauperism, and both reports agree that the first step towards a remedy lies in a national system of labour exchanges; the next in insurance against unemployment. It is obvious that no scheme of insurance can be safe from abuse unless backed by an efficient organisation of the labour market, *i.e.*, by a fairly complete registration of all the employment offering. With such registration the insurance fund would be adequately protected, for men would not be allowed to remain on the fund after there was work anywhere available for them to do. The trade unions cannot safely now make their benefits really adequate, because, though they have something of a registration system, they have very little. They still rely mainly upon their members

finding work by personal application. As Mr. W. H. Beveridge puts it in "Unemployment," the labour exchange is required to reduce to a minimum the intervals between successive jobs. Insurance is required to tide over the intervals that will still remain. The labour exchange mobilises the reserves of labour for fluctuations and hastens re-absorption after changes of industrial structure. Insurance is needed to provide for the maintenance of the reserves while standing idle and of the displaced men while waiting for re-absorption. The majority report of the Commission recommends that, associated with the labour exchange, there should be, in connection with every public elementary school, an intelligence bureau, which would advise parents and teachers as to the branches of employment likely to give the best opening for children leaving school. By this means the Commission consider that boys might be directed from the "blind alley occupations" which so many enter at present into occupations which will lead to permanent employment.

Insurance Against Unemployment.—In the opinion of the Commissioners there seems room and necessity for a great extension of insurance against unemployment, and they recommend the encouragement of a State subsidy. They have examined the many experiments now being tried in other countries in this direction, but they know of no scheme, either foreign or British, so free from objection as to justify them in specifically recommending it for general adoption, and, accordingly, they have recommended that a small Commission, or Inter-Departmental Committee, of experts and representatives of existing trade benefit organisations, be appointed, with instructions to frame a scheme or schemes for consideration. There are, no doubt, great difficulties in the matter, but there are also great possibilities. There are schemes of direct voluntary insurance with municipal authorities in Berne, Basle, Cologne, and Leipzig. And there has been one attempt at compulsory insurance in St. Gall. The most promising of these schemes is, perhaps, the "Ghent system" of supplementing grants made to their unemployed members by trade unions and other associations. This plan has spread from Ghent to other Belgian towns, and has now been adopted experimentally by the national Governments of France, Norway, and Denmark, and by the city of Strasburg. In Germany where, speaking generally, the matter is still in the stage of discussion not of practice, the possibility of a general compulsory scheme to set beside the existing provision for infirmity, sickness, and accident, has been much considered. The whole subject has been investigated by the Imperial Statistical Department, which published a report in 1906. A useful summary of the conclusions of this Report, and of the principal foreign insurance schemes discussed, is given by the Report of a Special Committee of the Charity Organisation Society on Unskilled Labour, pp. 67-77. The conclusion arrived at by the Department was, that the facts of unemployment presented no insuperable difficulties of a technical character to the formation of an insurance system. The real difficulties were held to be in a different direction, in defining the conception of the "unemployment" which should entitle to benefit, and the obligation of the insured workman to take such work as should be offered to him. The real difficulty is that of the test of unemployment. "On one point," says the Report, "all proposals agree, one point emerges clear in the adjudication upon every practical scheme, that in every form of unemployed benefit or insurance an adequate system of Labour Exchanges is of first importance." In the opinion of the German experts, there would be no impossibility in the State applying the principle of insurance to the risk of unemployment quite generally and compulsorily, once a test of unemployment had been made available.

The Living-in System.—A deputation representing the Parliamentary Committee of the Trades Unions Congress has been discussing with the Home Secretary the living-in system and shop hours. The deputation wanted Mr. Gladstone to invite Parliament to put an end to the living-in system, but the Home Secretary could not be induced to say more than that he would be very glad if facilities were given for the discussion of the report of the Truck Committee, which deals with that subject. It will be remembered that the evidence laid before the Truck Committee was contradictory. Admittedly the system worked well in some cases, and the majority did not feel justified in advocating its abolition in their Report. They recommended precautions which should ensure wholesome food and suitable premises, with adequate sanitary arrangements. They suggested inspection by the officers of the Local Authority, which already enforces the Shop Hours Act. A minority Report, however, recommended the legal prohibition of living-in. It will hardly be disputed that this living-in system is opposed to the principle of the Truck Acts, namely, that the purchaser of a certain number of hours of labour has no right to dictate the manner in which any part of the purchase money shall be spent, nor to exercise any sort of jurisdiction over any hours beyond those which he purchases; and there is much to be said for the contention that no contract invalidating such claims ought to be recognised by the law. In the better kind of shops the more obvious evils of the living-in system are absent, but the better-class shops are comparatively few, and the evidence points strongly to the advisability of the legal abolition of living-in. "Living-in," when an employer can no longer make it compulsory, might become quite a pleasant way of living.

Shipbuilding in Manchester.—Already one of the great ports of the United Kingdom, Manchester s beginning to think about shipbuilding, and the

thing which gives her the opportunity to enter the lists as a shipbuilding centre is her unrivalled experience of gas-engines. The gas-engine is steadily making progress towards becoming a recognised marine engine. It saves both in the cost of fuel and in the gross dead weight of machinery and fuel which the ship has to carry, two of the most important considerations in marine engineering. Already some of the Manchester gas-engine makers are devoting themselves to the marine gas-engine problem. Writing to the *Manchester Guardian*, an engineering correspondent says that Manchester men ought to be prepared to proceed to the logical conclusion and build marine gas-engines in Manchester, which would mean that they must build ships there. Says the correspondent, "We have cheap power and material. We can readily procure skilled designers and men. We have a big shipping port, and a considerable ship-repairing experience. Manchester has, too, courage, foresight, and a progressive business spirit. We ought to have a shipbuilding industry, and to that end we need a co-operation of interests. The Ship Canal Company, the local governing bodies, Manchester shipowners, the Manchester Dry Docks Company, local engineers (and particularly makers of gas engines), all stand to gain by the foundation and growth of shipbuilding in Manchester, and should all pull together for the common benefit." The marine engine is now in process of being overhauled not so much in details as in its general features. The reciprocating engine still holds the greater part of the field, but has lost a portion to the steam turbine, which is not yet the result of years of experience and standardisation, and can therefore be built as well in Manchester as on the Clyde or Tyne, whilst both are in fear of a combination of high-speed turbo-electric generators and slow-speed motors, in which Manchester has had more experience than Glasgow, Belfast, or Southampton.

The Clyde and the Thames.—When some two years ago Messrs. Yarrow and Company left the Thames for the Clyde, attention was directed in these Notes to the serious disadvantages with which the Thames has to reckon as a seat of the shipbuilding and marine engineering industry. The experience of Messrs. Yarrow on the Clyde amply confirms this view. In a statement they have just published they put the actual saving affected by the transference of their works to the Clyde at 10 per cent. on the cost of production. Taxes are only one-third what they were in London; labour is both cheap and plentiful, particularly, unskilled wages for skilled labour being from 5 to 10 per cent. less, and for unskilled over 30 per cent.; the works are in the very heart of the Scottish coal and iron producing centres, and the mileage saved in carriage means a very considerable item of expenditure; electricity at Scotstoun, for power and lighting, is supplied at the uniform rate of ¾d. per unit; whilst the measured mile at the mouth of the Clyde is the best on the British coast.

NOTES ON BOOKS.

MODERN COMMERCIAL CORRESPONDENCE. By John King Grebby. London: Macdonald and Evans. 2s. 6d.

This book has been designed to assist the young student who is endeavouring to acquire a good style of commercial letter writing and a knowledge of commercial terms and business practice. It is a deplorable fact that for many years the subject which has been most neglected or least successfully taught in English schools is English composition. Signs are not wanting that schoolmasters are at last awaking to the necessity of remedying this state of things, but as yet only a beginning has been made in this direction, and Mr. Grebby has probably learnt from painful experience as examiner for the Royal Society of Arts, that it is not unnecessary to warn the aspiring commercial clerk that in writing a letter to a firm he should begin a letter with the words, "Dear Sirs, or Gentlemen (never Gents.)." The volume contains some useful and not uncalled for hints on grammar, arrangement of a business correspondence, paragraphing, &c., a large collection of specimen letters, and a section explaining the most ordinary commercial terms; and it should prove of service to candidates preparing themselves to enter for the various commercial examinations.

THE BRITISH EMPIRE (AND JAPAN). By W. Bisiker, F.R.G.S. London: The Geographical Publishing Co. 21s. net.

In conceiving the plan of this elaborate and comprehensive atlas, Mr. Bisiker has departed in many directions from the conventional lines that have been in vogue for the last two or three generations. The scope of the work is indicated by its full title: "The British Empire—its Features, Resources, Commerce, Industries, and Scenery; together with the Physical and Economic Conditions of the World." The subject is a vast one, but it will be seen that the author has made a conscientious attempt to treat it thoroughly when it is stated that the book contains 213 maps and 272 photographic illustrations and drawings, depicting all phases of home and colonial life, together with numerous tables and diagrams, brief histories and statistics, and a descriptive dictionary of commercial products. Mr. Bisiker has endeavoured to make the maps interesting in themselves by emphasising the chief points and features, and not overcrowding them with the less important details. The maps which he has provided are of all descriptions—political maps, showing railways, navigable inland waterways, submarine cables, steamship routes, shipping ports, &c.; relief maps, in which the chief surface features are boldly indicated; maps showing the distribution of various animal, vegetable, and mineral products, and the industries; and numerous maps on a small scale dealing with the density of populations, and climate, including varie-

ties of temperature, atmospheric pressure, prevailing winds, annual rainfall, and so forth. The student who has mastered the contents of this atlas ought to have a very fair idea of what is meant by the words "The British Empire."

THE MANUFACTURE OF EXPLOSIVES—TWENTY YEARS' PROGRESS. By Oscar Guttmann, M.Inst.C.E., F.I.C., F.C.S., &c. London: Whittaker and Co. 3s. net.

This volume contains the series of Cantor Lectures which were delivered before the Royal Society of Arts on November 23rd and 30th, and December 7th and 14th, 1908. As they have already been printed in the *Journal*, members of the Society know that they contain an outline of the many improvements and researches effected in the manufacture of explosives during the last twenty years, together with a succinct and valuable summary of the most important results achieved. The lectures are the fruit of much careful enquiry and research, and are now presented to the public in a handy and useful form.

QUESTIONS AND ANSWERS.

NOTICES TO CORRESPONDENTS.

On all communications must be written the name and address of the sender, not necessarily for publication, but as a guarantee of good faith.

Each question or reply should be written on a separate sheet of paper, and should bear such signature of the writer and such address as he wishes to appear.

Questions which can be answered from the usual books of reference, will not be printed.

ANSWERS.

DISTINCTION BETWEEN ENAMEL AND GLASS.—I think it would be very difficult to frame any exact scientific definition of enamel and glass respectively which would serve generally to differentiate these substances. I do not profess to be an authority on enamel or glass, but in my view enamel is simply a comparatively fusible kind of glass, the difference in this respect being in some cases due to the altered proportions in which some of the constituents are present. If this view be accepted, it follows that there is no essential chemical difference, except as regards proportions, and probably no sharp line of demarcation, even in this limited respect, could be drawn, though, no doubt, there are mixtures of ingredients which make good glass, but would not, in any proportions, give a satisfactory enamel. Pottery-glaze may, I think, be defined as a transparent kind of enamel.—BOVERTON REDWOOD.

QUESTIONS.

SHEFFIELD PLATE.—Can any member tell me who was the first manufacturer of Sheffield plate?—LEEDS.

VIENNA LIME.—What is Vienna lime? I have inquired of several lime merchants, but none of them appear to know anything about it.—BUILDER.

RUST-PROOF.—I am anxious to find some simple method of rendering rust-proof iron bolts and screws which are submerged in salt water.—FORTH BRIDGE.

GENERAL NOTES.

SCHOLARSHIPS IN SANITARY SCIENCE.—With the object of encouraging original research in sanitary science, the Grocers' Company offer two scholarships, each of £300 a year, with an allowance to meet the cost of apparatus and other expenses in connection with the work, tenable for one year, but renewable for a second or third year, subject to the conditions of the scheme under which they are established. The next election will take play in May. Applications must be sent in before April 1 to the Clerk of the Grocers' Company, Grocers' Hall, London, E.C.

UNEMPLOYMENT AND EMIGRATION.—Among their many recommendations for the relief of distress, the Royal Commission on the Poor-law, majority report, recommend emigration. As to it the Commission found considerable diversity of opinion amongst their witnesses, but the point it is desired to notice here is the character of the emigration now going on. In answer to the objection that the best men are sent away whilst the worst remain on our hands, the Commission say that an analysis of those sent by the Central Unemployed Body for London shows that a large proportion were unskilled labourers, and that of over 250 married and single applicants assisted out by the West Ham Distress Committee four only were of the "skilled and regular artisan" class. The Lingfield Labour Colony, which deals with "the dull, the drunken, the intractable, the lazy, the physically and mentally unfit, and the unfortunate," finds emigration the best method of dealing with its cases after reclamation; and the Church Army considers emigration "a most successful and ready means of permanently benefiting" the residuum with which it deals. And no doubt, from their point of view, these organisations are right, but it is not surprising that Canada, where most of the emigrants are sent, is beginning to question whether this is a serviceable class of immigrants.

INDUSTRIAL ALCOHOL AND FIBRE FROM LEAVES.—During the last half-century much skill and enterprise have been devoted to the utilisation of "waste" resulting from mining, industrial, and other pro-

cesses. Intelligence, technical and commercial, has come to the rescue, and waste, now called by-products, is made the source of great and ever-increasing profit. Mr. Henry Barraclough sends the *Journal* a reprint of an article in which he directs attention to the treatment, by greatly improved and novel methods, of leaves and stems of certain classes of plants. Not only can their fibre be extracted, their juices can be utilised for the production of industrial alcohol. Thus two valuable articles of commerce are produced from the same raw materials. Mr. Barraclough refers to many varieties of the Agave (aloe) family, and also of the closely allied families of Fourcroya and Maguey, also of the Sanseviera family. There are other plants the leaves and stems of which contain equally valuable fibres and juices. Many of these plants are at present cultivated solely for the production of their fibre, but they are also valuable for alcohol, and attention is now being directed to the exploitation of large areas covered with these plants. Industrial alcohol is being increasingly used. All kinds of engines—stationary, portable, for motors, for road and water transport—can be driven by it; it is used for agricultural and industrial purposes, heating houses, cooking, &c. It can be obtained at comparatively small cost by means of greatly improved and novel methods of treating the leaves and stems, and where they are available growers and landowners can advantageously combine to sell and deliver them to central works for treatment.

Illuminating Engineering Society for England.—At an informal dinner, held at the Criterion Restaurant, on the 9th inst., at which representatives of the engineering, architectural, medical, and other interested professions were present, the formation of an Illuminating Engineering Society in this country was discussed. Mr. Leon Gaster, the Chairman, briefly described the development and progress of the illuminating engineering movement in this country, and explained the objects of the proposed society, namely, to provide a free and impartial platform for the discussion of questions connected with illumination. He emphasized especially the fact that what he proposed was an "Illuminating Engineering Society" and not a Society of "Illuminating Engineers." Any one interested in furthering the science and art of illuminating engineering would be able to join the society; membership, however, would not entitle any one to any professional status. In this respect the society would resemble similar and flourishing institutions already existing in this country. An animated discussion followed, in which all who spoke expressed their warm approval of the suggested scheme, and their conviction that the time was ripe for starting such a society. It was proposed and carried unanimously that *The Illuminating Engineer*, published in London, be appointed the official organ of the society. For further particulars regarding this society application should be made to Mr. Leon Gaster, 42, Victoria-street, S.W.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

March 3.—"Dew-ponds." By George Hubbard, F.S.A., F.R.I.B.A. Sir Edwin Durning-Lawrence, Bart., B.A., LL.B., will preside.

March 10.—"The Application of the Microscope to the Study of Metals." By Walter Rosenhain. R. T. Glazebrook, M.A., Sc.D., F.R.S., Director of the National Physical Laboratory, will preside.

March 17.—"The Musical Aspect of Drums." By Gabriel G. Cleather. [The paper will be illustrated by short selections from the works of the great masters, with the assistance of Mrs. Stansfeld Prior at the pianoforte.] Sir Charles Villiers Stanford, M.A., Mus.D., D.C.L., LL.D., will preside.

March 24.—"Afforestation and Timber Planting in Great Britain and Ireland." By J. Nisbet.

Dates to be hereafter announced:—

"Railway Development in China." By Arthur John Barry, M.Inst.C.E.

"The Resources of Peru." By C. Reginald Enock, F.R.G.S.

"The Foundations of Stained Glass Work." By Noel Heaton, B.Sc., F.C.S.

"The Manufacture of Nitrate of Lime." By Sam Eyde.

"The Teaching of Design." By E. Cooke.

"Furniture Design and Construction—Ancient and Modern." By Percy A. Wells.

"The Principles of Heredity as Applied to the Artificial Production of new forms of Plants and Animals." (Aldred Lecture.) By Professor Arthur Dendy, D.Sc., F.R.S., F.L.S.

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

March 25.—"Native Man in Southern India." By Edgar Thurston, Superintendent, Ethnographic Survey, Madras.

April 29.—"The Problem of Indian Labour Supply." By Selwyn Howe Fremantle, I.C.S.

May 13.—"Some Phases of Hinduism." By Krishna Gobinda Gupta (Member of the Council of India).

May 27.—"The Function of Schools of Art in India." By Cecil L. Burns, Principal of the Bombay School of Art. Professor Sir Hubert von Herkomer, C.V.O., D.C.L., R.A., will preside.

Colonial Section.

Tuesday afternoons, at 4.30 o'clock:—

March 16.—"The Colonial Wool Trade." By S. Banks Hollings.

April 6.—"Ceylon: its Industries and Material Progress." By the Hon. John Ferguson, C.M.G. The Rt. Hon. Sir West Ridgeway, G.C.B., G.C.M.G., K.C.S.I., will preside.

May 4.—

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

LEON GASTER, A.M.I.E.E. (Editor of the "Illuminating Engineer"), "Modern Methods of Artificial Illumination." (Four Lectures.)

LECTURE III.—MARCH 1.—*Lighting by Candles, Oil, Acetylene, Petrol, Air-Gas, Alcohol, and other Illuminants.*—The candle and other early systems—The petroleum lamp, its merits and drawbacks—The petrolite lamp—High pressure systems of Kitson, &c.—Modern petrol air-gas systems and their merits—Lighting by alcohol and other liquid fuels—Acetylene, its early development and difficulties—Modern types of burners—Applications to incandescent mantles—Liquid acetylene—Summary of position of modern illuminants—Comparisons of quality for lighting and radiant efficiency—Researches for further improvements.

Each lecture will be fully illustrated by working specimens of the lamps and apparatus described.

GEORGE GERALD STONEY, M.Inst.C.E., "Steam Turbines." Three Lectures.

March 22, 29, April 5.

F. W. LANCHESTER, "Aerial Flight." Three Lectures.

April 26, May 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 1...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Leon Gaster, "Modern Methods of Artificial Illumination." (Lecture III.)

Farmers' Club, Whitehall-rooms, Whitehall-place, S.W., 4 p.m. Major P. G. Craigie, "The Comparative Cost of Farm Labour."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7½ p.m. Dr. J. S. Owen, "A New Test for Concrete."

Victoria Institute, 1, Adelphi-terrace, W.C., 4½ p.m. Rev. Chancellor Lias, "Modernism: its Origin and Tendencies."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. J. W. Lovibond, "Some Requirements of a Colour Standard." 2. Mr. A. R. Ling, "Studies on Malting. No. I.—The Production of Diastase during Germination." 3. Mr. G. N. Huntley, "Sulphur as a Cause of Corrosion in Steel." 4. Mr. J. F. Briggs, "A Brief Review of our Present Knowledge of Cellulose as a Polysaccharide."

TUESDAY, MARCH 2...Faraday Society, 92, Victoria-street, S.W., 8 p.m. 1. Mr. V. H. Veley and Dr. J. C. Cain, "On the Rate of Evolution of Gases from Homogeneous Liquids." 2 Dr. F. M. Perkin, "The Electro-analysis of Mercury Compounds with a Gold Cathode." 3. Dr. E. B. R. Prideaux, "The Relation between Composition and Conductivity in Solutions of Meta- and Ortho-Phosphoric Acids."

East India Association, Westminster Palace Hotel, S.W., 4 p.m. Mr. A. E. Duchesne, "Race, Creed, and Politics in India."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. F. W. Mott, "The Evolution of the Brain as an Organ of Mind." (Lecture II.)

Alpine Club, 23, Savile-row W., 8½ p.m.

Child Study Society, Parkes Museum, Margaret-street, W., 7½ p.m. Annual General Meeting. 8 p.m. Prof. J. Adams, "Mental Development of Children."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. Magnus Mowat's paper "Some Recent Grain-handling and Storing Appliances at the Millwall Docks."

Photographic, 66, Russell-square, W.C., 8 p.m. Mr. F. Martin Duncan, "The Application of Photography to Scientific Research."

WEDNESDAY, MARCH 3...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. G. Hubbard, "Dew-Ponds."

United Service Institution, Whitehall, S.W., 4 p.m. Annual General Meeting.

Botanic, Inner-circle, Regent's-park, N.W., 4 p.m. Dr. F. E. Fritsch, "Water Plants."

Royal Archæological Institute, 20, Hanover-square, W., 4½ p.m. Mr. R. Garraway Rice, "Such Portions of Sussex Churches as can be Dated from Bequests in Early Wills." (Part I.)

THURSDAY, MARCH 4...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. Miss L. S. Gibbs, "The Montane Flora of Fiji."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. Hans Gadow, "Problems of Geographical Distribution in Mexico." (Lecture III.)

Civil and Mechanical Engineers, Caxton Hall, Westminster, S.W., 8 p.m. Mr. R. Borlase Matthews, "Some Commercial Aspects of the Management of Central Electricity Supply Stations."

Chemical, Burlington-house, W., 8½ p.m. 1. Messrs. G. Martin and F. S. Kipping, "The Action of Anhydrosulphuric Acid on Triphenylsilcol." 2. Messrs. H. B. Dixon and B. F. Coward, "The Ignition Temperatures of Gases." 3. Messrs. N. L. Gebhard and H. B. Thompson, "Diazo-oxy-amido Compounds and the Influence of Substituting Groups on the Stability of their Molecules." 4. Messrs. A. T. de Moulpied and A. Rule, "Tetraketopiperazine II." 5 Mr. H. E. Watt, "The Alkoloids of *Senecio latifolius*." 6. Mr. O. Flaschner, "The Miscibility of the Pyridene Bases with Water and the Influence of a Critical Solution Point in the Shape of the Melting Point Curve." 7. Messrs. M. O. Forster and F. P. Dunn, "An Interpretation of the Hantzsch-Werner Hypothesis." 8. Mr. M. O. Forster, "The Triazo Group. (Part IX.) Transformation of Cinnamoylazoimide into Cinnamenylcarbimide (Cinnamenyl *iso* Cyanate)." And other papers.

FRIDAY, MARCH 5.. Royal Institution, Albemarle-street, W., 9 p.m. Viscount Esher, "The Letters of Queen Victoria."

Architectural Association, 18, Tufton-street, S.W., 7½ p.m.

Geologists' Association, University College, Gower-street, W.C., 8 p.m. 1. Mr. L. Richardson, "The Sections of Inferier Oolite on the Midford-Camerton Section of the Limpley Stoke Railway, Somerset." 2. Mr. Gustave F. Dollfus, "The Geology of the Paris Basin."

SATURDAY, MARCH 6...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Sir J. J. Thomson, "The Properties of Matter." (Lecture II.)

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FRIDAY, MARCH 5, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MARCH 8th, 8 p.m. (Cantor Lecture.) LEON GASTER, A.M.I.E.E., "Modern Methods of Artificial Illumination." (Lecture IV.)

WEDNESDAY, MARCH 10th, 8 p.m. (Ordinary Meeting.) WALTER ROSENHAIN, "The Application of the Microscope to the Study of Metals."

Further particulars of the Society's meetngs will be found at the end of this number.

QUESTIONS AND ANSWERS.

In view of the fact that the Royal Society of Arts includes amongst its members authorities on almost every branch of human knowledge, it has been suggested that the value and interest of the *Journal* would be greatly enhanced if some space were devoted to correspondence of the "Notes and Queries" order. Readers in search of information on particular points which cannot be obtained from the usual books of reference, are, therefore, invited to make their wants known in the *Journal*, in the hope that they may be assisted in their difficulties by their fellow members. Further particulars will. be found under the heading "Questions and Answers," on p. 343.

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal of the Royal Society of Arts for 1909 early in May next, and they, therefore, invite members of the Society to forward to the Secretary on or before Saturday the 3rd April, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce," and has been awarded as follows in previous years :—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., "for his great services to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects."

In 1866, to Michael Faraday, D.C.L., F.R.S., "for discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S., "for the invention and manufacture of instruments of measurement and uniform standards by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I., "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the Department of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (afterwards Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvements in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to Manufactures and the Arts."

In 1875, to Michel Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential services in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy and in magnetism, and by his improvements in the application of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong (afterwards Lord Armstrong), C.B., D.C.L., F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious manual labour."

In 1879, to Sir William Thomson (afterwards Lord Kelvin), O.M., LL.D., D.C.L., F.R.S., "on account of the signal service rendered to Arts, Manufactures, and Commerce, by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science to industrial pursuits."

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin, "for eminent services rendered to the Industrial Arts by his investigations in organic chemistry, and for his successful labour in promoting the cultivation of chemical education and research in England."

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S., "for his researches in connection with fermentation, the preservation of wines, and the propagation of zymotic diseases in silkworms and domestic animals, whereby the arts of wine-making, silk production, and agriculture have been greatly benefited."

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S., "for the eminent services which, as a botanist and scientific traveller, and as Director of the National Botanical Department, he has rendered to the Arts, Manufactures, and Commerce by promoting an accurate knowledge of the floras and economic vegetable products of our several colonies and dependencies of the Empire."

In 1884, to Captain James Buchanan Eads, "the distinguished American engineer, whose works have been of such great service in improving the water communications of North America, and have thereby rendered valuable aid to the commerce of the world."

In 1885, to Mr. (afterwards Sir) Henry Doulton, "in recognition of the impulse given by him to the production of artistic pottery in this country."

In 1886, to Samuel Cunliffe Lister (afterwards Lord Masham), "for the services he has rendered to the textile industries, especially by the substitution of mechanical wool combing for hand combing, and by the introduction and development of a new industry —the utilisation of waste silk."

In 1887, to HER MAJESTY QUEEN VICTORIA, "in commemoration of the progress of Arts, Manufactures, and Commerce throughout the Empire during the fifty years of her reign."

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S., "in recognition of the value of his researches in various branches of science and of their practical results upon music, painting, and the useful arts."

In 1889, to John Percy, LL.D., F.R.S., "for his achievements in promoting the Arts, Manufactures, and Commerce, through the world-wide influence which his researches and writings have had upon the progress of the science and practice of metallurgy."

In 1890, to Dr. (afterwards Sir) William Henry Perkin, F.R.S., "for his discovery of the method of obtaining colouring matter from coal tar, a discovery which led to the establishment of a new and im-

portant industry, and to the utilisation of large quantities of a previously worthless material."

In 1891, to Sir Frederick Abel, Bart., G.C.V.O., K.C.B., D.C.L., D.Sc., F.R.S., "in recognition of the manner in which he has promoted several important classes of the Arts and Manufactures, by the application of Chemical Science, and especially by his researches in the manufacture of iron and of steel; and also in acknowledgment of the great services he has rendered to the State in the provision of improved war material, and as Chemist to the War Department."

In 1892, to Thomas Alva Edison, "in recognition of the merits of his numerous and valuable inventions, especially his improvements in telegraphy, in telephony, and in electric lighting, and for his discovery of a means of reproducing vocal sounds by the phonograph."

In 1893, to Sir John Bennet Lawes, Bart., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S., "for their joint services to scientific agriculture, and notably for the researches which, throughout a period of fifty years, have been carried on by them at the Experimental Farm. Rothamsted."

In 1894, to Sir Joseph (afterwards Lord) Lister, F.R.S., "for the discovery and establishment of the antiseptic method of treating wounds and injuries by which not only has the art of surgery been greatly promoted, and human life saved in all parts of the world, but extensive industries have been created for the supply of materials required for carrying the treatment into effect."

In 1895, to Sir Isaac Lowthian Bell, Bart., F.R.S., "in recognition of the services he has rendered to Arts, Manufactures, and Commerce by his metallurgical researches and the resulting development of the iron and steel industries."

In 1896, to Prof. David Edward Hughes, F.R.S., "in recognition of the services he has rendered to Arts, Manufactures, and Commerce, by his numerous inventions in electricity and magnetism, especially the printing telegraph and the microphone."

In 1897, to George James Symons, F.R.S., "for the services he has rendered to the United Kingdom by affording to engineers engaged in the water supply and the sewage of towns a trustworthy basis for their work, by establishing and carrying on during nearly forty years systematic observations (now at over 3,000 stations) of the rainfall of the British Isles, and by recording, tabulating, and graphically indicating the results of these observations in the annual volumes published by himself."

In 1898, to Professor Robert Wilhelm Bunsen, M.D., For. Memb. R.S., "in recognition of his numerous and most valuable applications of Chemistry and Physics to the Arts and to Manufactures."

In 1899, to Sir William Crookes, F.R.S., "for his extensive and laborious researches in chemistry and in physics; researches which have, in many instances, developed into useful practical applications in the Arts and Manufactures."

In 1900, to Henry Wilde, F.R.S., "for the discovery and practical demonstration of the indefinite increase of the magnetic and electric forces from quantities indefinitely small, a discovery now used in all dynamo machines; and for its application to the production of the electric search-light, and to the electro-deposition of metals from their solutions."

In 1901, to His Majesty the King, "in recognition of the aid rendered by His Majesty to Arts, Manufactures, and Commerce during thirty-eight years' Presidency of the Society of Arts, by undertaking the direction of important exhibitions in this country and the executive control of British representation at International Exhibitions abroad, and also by many other services to the cause of British Industry."

In 1902, to Professor Alexander Graham Bell, "for his invention of the Telephone."

In 1903, to Sir Charles Augustus Hartley, K.C.M.G., "in recognition of his services, extending over 44 years, as Engineer to the International Commission of the Danube, which have resulted in the opening up of the navigation of that river to ships of all nations, and of his similar services, extending over 20 years, as British Commissioner on the International Technical Commission of the Suez Canal."

In 1904, to Walter Crane, "in recognition of the services he has rendered to Art and Industry by awakening popular interest in Decorative Art and Craftsmanship, and by promoting the recognition of English Art in the form most material to the commercial prosperity of the country."

In 1905, to Lord Rayleigh, O.M., D.C.L., Sc.D., F.R.S., "in recognition of the influence which his researches, directed to the increase of scientific knowledge, have had upon industrial progress, by facilitating, amongst other scientific applications, the provision of accurate electrical standards, the production of improved lenses, and the development of apparatus for Sound Signalling at Sea."

In 1906, to Sir Joseph Wilson Swan, M.A., D.Sc., F.R.S., "for the important part he took in the invention of the incandescent electric lamp, and for his invention of the carbon process of photographic printing."

In 1907, to the Earl of Cromer, O.M., G.C.B., G.C.M.G., K.C.S.I., C.I.E., "In recognition of his preëminent public services in Egypt, where he has imparted security to the relations of this country with the East, has established justice, restored order and prosperity, and, by the initiation of great works, has opened up new fields for enterprise."

In 1908, to Sir James Dewar, M.A., D.Sc., LL.D., F.R.S., "For his investigations into the liquefaction of gases and the properties of matter at low temperatures, investigations which have resulted in the production of the lowest temperatures yet reached, the use of vacuum vessels for thermal isolation, and the application of cooled charcoal to the separation of gaseous mixtures and to the production of high vacua."

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURE.

On Monday evening, March 1st, Mr. LEON GASTER, A.M.I.E.E., delivered the third lecture of his course on "Modern Methods of Artificial Illumination." The lecture was illustrated with apparatus kindly lent by the following firms :—

Messrs. the Gas Economising and Improved Light Syndicate, Limited (Blanchard System).—One 500 candle-power self-contained paraffin incandescent lamp, fitted with inverted burner; one portable table lamp working on the same system.

Messrs. the United Kingdom Lighting Trust, Limited.—Examples of latest type of (Kitson) "Empire" incandescent petroleum self-contained lamp of 1,000 candle-power.

Messrs. Petrolite, Limited.—Two examples of "Petrolite" petroleum incandescent lamps.

Messrs. Falk, Stadelmann and Company, Limited.—Specimen of "Lucisca" portable petroleum incandescent lamp.

Messrs. the Universal Gas Methane and "Buisson Hella" Company, Limited.—Portable incandescent petroleum lamp, fitted with "Hella Bushlight" mantle and burner.

Messrs. the Machine Gas Syndicate (Cox's Air-Gas System). — Complete plant (estimated capacity 280 cubic feet per hour, 28 lights each consuming 10 cubic feet, and yielding 125 candle-power), supplying air-gas to various burners, the gas being passed through a piping immersed in a freezing mixture, with the object of demonstrating that there is no condensation in the pipes.

Messrs. the National Air-Gas Company, Limited (Glascoe's Patent).—Exhibition of complete plant (20 burners of 30 candle-power, or 40 of 25 candle-power, 100 cubic feet per hour estimated capacity), feeding various types of inverted and other incandescent mantles.

Messrs. Strode and Co. (Aerogen system).—Exhibition of complete Aerogen plant, estimated capacity 35 burners, each consuming 2 cubic feet of gas, and yielding 25 candle-power, supplying petrol air gas to various inverted and other burners.

Messrs. the Acetylene Illuminating Co., Limited.—Complete dissolved acetylene outfit, suitable for motor-cars and other purposes; De Lane's automatic lighting appliances for buoys, &c.; oxy-acetylene flame for lanterns, &c.

Messrs. the Standard Acetylene Co.—Complete generating plant to receive a charge of 12 lbs. carbide, estimated capacity 30 burners, consuming 10 cubic feet of gas per hour; water to carbide feed type, supplying a series of elegant types of burners.

Messrs. R. Frister and Co., Limited (Oberschonweide, Berlin).—Examples of "Tubus" incandescent gas-burner, capable of burning in horizontal position.

A specimen of non-combustible carborundum wick for use with spirit-lamp, &c., the invention of Dr. B. Monasch, of Augsburg, was also on exhibition.

[All these exhibits were shown in actual operation.]

The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION.

Thursday, February 25, 1909; SIR RICHARD TEMPLE, Bart., C.I.E., in the chair.

The paper read was—

THE BUDDHIST AND HINDU ARCHITECTURE OF INDIA.

By ARTHUR ANTHONY MACDONELL, M.A., Ph.D., F.B.A.,

Boden Professor of Sanskrit, University of Oxford.

The literary records of India, beginning with the Rigveda, go back to an earlier date than those of any other Indo-European people; but they supply hardly any information about chronology, because of the total lack of works of a historical character during the enormous period extending from the rise of Indian literature (perhaps as early as 1500 B.C.) and the beginning of the Mohammedan Conquest (c. 1000 A.D.). We are accordingly very largely dependent on archæology in its various branches for the reconstruction of the external history of the religious and social institutions as well as of the political events of early times. The study of archæology is, therefore, relatively more important in India than in perhaps any other country of the present day. But the ancient monuments in which so much information lies buried have been disappearing from the face of the land. Thousands have been lost for ever. Vast numbers were destroyed or mutilated by the Mohammedan invaders in bygone centuries. Many others have from time immemorial been used as quarries by neighbouring villagers. Others have fallen into irretrievable ruin simply through the ravages of time. Some antiquities of priceless value are known to have been destroyed within the last century. Thus the great Stūpa of Amāravatī in Southern India was standing less than one hundred years ago, but now there is hardly a trace of it left though several of its sculptures have been rescued for museums. It is recorded that about 60 cartloads of ancient Buddhist sculp-

tures were removed from Sārānth, near Benares, and thrown into the neighbouring river to form the foundations of a new bridge about a century ago. The tower of the splendid Sun Temple at Konārak, in Orissa, was in great part still standing 70 years ago, but since then has fallen entirely; but, as Fergusson, the archæologist, says, whether from stress of weather or by aid from the Public Works Department is by no means clear. If I am not greatly mistaken, the process of destruction has even been accelerated during the past century. Much damage has thus been done in the process of making roads, railways, and bridges. The effect of some of these operations I myself have seen. Great harm is also done, in Southern India especially, by the practice of pulling down old shrines and using the materials for building new ones. I saw an example of this at Madura. Some of the blocks of the old edifice were still lying about, one of them bearing half of what was probably the most ancient inscription yet found in that part of the country. The other half had disappeared, having doubtless been built into the wall of the new shrine. Buried sites have further been often greatly injured by the operations of untrained and irresponsible excavators, and innumerable sculptures of great archæological value have been thus dispersed and lost. This disastrous state of things at once attracted the attention of Lord Curzon on his arrival in India as Viceroy. Without delay he proceeded to reorganise the Archæological Department on a permanent and systematic footing. He then, in the year 1904, passed the Ancient Monuments Preservation Act, by which he has conferred a benefit of the very greatest importance on India. The ancient monuments of the country are now under the direct charge of the Archæological Department. All that survive will henceforth be carefully preserved and kept in repair. Ancient sites will no longer be at the mercy of amateur excavators. Archæological finds will be placed in Government museums and all traffic in them put a stop to. I had many opportunities of seeing the beneficial effects of this Act during a tour of six months which I recently made in India and Ceylon, where I visited all the most important archæological remains. Of these I took many photographs and very full notes. I propose to restrict what I am going to say about these ancient monuments to what I have seen with my own eyes, excepting only a few references to later developments in other countries to which Buddhism spread from India.

In the pre-Buddhistic phase of Indian religion from which Hinduism is directly descended, carved images of the gods and temples for worship were equally unknown. It is hardly to be expected that the very rudimentary art of that early age should have attempted to represent in an anthropomorphic form gods which were still felt to be the deifications of natural phenomena, such as sun, fire, sky, wind. And in the absence of images, structural places of worship would not be wanted. The fire and Soma ritual of this early age was conducted in an open air enclosure, or in connection with the domestic hearth.

Thus, though the earliest record of Indian religion, the Rigveda goes back to a very ancient date, probably 1500 B.C., Indian religion did not begin to express itself in the form of structural and plastic art till a comparatively late period. For none of the architectural or sculptural antiquities which survive in India can, with one exception, be dated earlier than 260 B.C. These earliest remains are all connected with religion; and the form of religion which they illustrate is Buddhism. The one exception is a brick Stūpa or relic mound at Piprahwa, on the Nepal frontier, which was explored ten years ago, and has, with probability, been assigned to 450 B.C.

It is with the reign of Asoka, the great Emperor (264-227 B.C.), whose rule extended practically over the whole peninsula, that the history of Indian art can really be said to begin. Originally an adherent of the Brahman religion, he became a convert to the doctrine of Buddha and devoted himself to promoting its interests, during the remainder of his life.

The history of Buddhist architecture in India extends over about nine centuries, and may be divided into three roughly equal periods. The earliest period reaches from 250 B.C. to 50 A.D. The monuments which survive from this period are almost exclusively the work of Buddhists. It was the Buddhists who introduced the use of stone in architecture at the commencement of this period. The Buddhists, in fact, were the first who built with stone in India. For some centuries before the beginning of this period, the architectural use of brick had been known, as is proved by the Stūpa of Piprahwa, which, as I have already said, probably dates from 450 B.C. But the ornamental buildings of the pre-Asokan age must have been built of wood,

like the modern palaces of Burma, only the substructures being made of brick. The whole history of Indian architecture points to previous construction in wood, the stone monuments being, to a large extent, imitations of wooden models. The second, and as far as Buddhist sculpture is concerned, best period, extends roughly from A.D. 50 to 350 A.D., the third period from 350-650 A.D.

The remains of Buddhist art in India are almost entirely architectural and sculptural; sculpture practically always appears in connection with the architecture, and invariably in the service of religion.

Early Buddhist architecture may be divided into three main groups :—(1) "Stūpas," or relic mounds; (2) "Chaityas," or places of worship, corresponding to our churches; and (3) "Vihāras," or dwellings for the monks.

I will begin with the "Stūpa." This is a dome-shaped structure which was a development of the low sepulchral tumulus or mound of earth, in which baked bricks were substituted for earth with a view to durability. The purpose for which they were erected by the Buddhists was to serve as monuments enclosing relics of Buddha or of Buddhist saints, which were placed in a stone coffer. Some, however, contained no relics, but were only commemorative of important events or miracles connected with the history of Buddha.

I will begin my account of Buddhist architecture with the Stūpa.

As representative of this form of structure we may take the large Stūpa at Sanchi in Central India, which, dating in all probability from the third century B.C., is an example of the Asoka type. Upon a substructure consisting of a low circular drum a hemispherical dome was erected. This dome was surrounded by a procession path forming the upper rim of the drum. On the top of the dome was a box-like structure surmounted by an umbrella (the Indian emblem of sovereignty), and surrounded by a stone railing. This structure is usually called a tee (a Burmese word). The tee has disappeared from all the Indian Stūpas, but its form can be seen from the Stūpas surviving in Ceylon, as well as from stone models and sculptural representations preserved in great numbers in India.

The Stūpa itself was surrounded by a massive stone railing, with gates on four sides, enclosing a procession path and a sacred precinct. Both the rails and the gates were unmistakable imitations of wooden models. The gateways, which are usually called by the Sanskrit name of Torana, were introduced into China and Japan along with Buddhist architecture from India. In China, under the name of Pailoos, they are frequently still constructed in wood; when made of stone they retain down to the present day the forms and details of wooden construction (like the gateways of Sanchi). A very remarkable thing in the history of this architectural feature is that these Pailoos are still used in China as gateways to simulated tombs just as their prototypes, the Toranas, were used at Sanchi 2,000 years ago.

Buddhism was introduced into Japan by way of Korea about 600 A.D. It is probable that the Japanese Tori-i, gateways similar in form to the Indian Toranas, and always found at the entrance of Shinto temples, are descendants of the Indian Toranas. There are similar gateways in Korea.

The earliest Stūpas were very low in proportion to their diameter. Thus the oldest known example, that of Piprahwa (450 B.C.), stands only about 22 feet high, with a diameter at the base of 116 feet. As time went on the relative height increased. Thus the great Stūpa at Sanchi, erected some 200 years later, is 54 feet high, while the basal diameter of the dome is 106 feet. The proportional height here is just about half, while at Piprahwa it is less than one-fifth.

The Stūpa of Sārnāth, near Benares, was erected several centuries later. Here the height is 110 feet above the surrounding ruins and 128 feet above the plain, with a diameter of 93 feet. Thus the height is now considerably more than the diameter. In other words, the Stūpa shows a tendency in course of time to assume the shape of a tower.

Concurrently with the elongation of the Stūpa we can see an elongation taking place in the tee also. This may be observed in chronologically successive rock-cut specimens at Ajanta. The combined elongation is well represented by a Stūpa found in Cambodia. The next step is a further elongation of the tee with a corresponding diminution and flattening of the main body of the Stūpa as shown by an example in Nepal. Here the umbrellas have disappeared and assumed the shape of thirteen roofs. In the Indian rock-cut specimens there are never more than three umbrellas, but in many of the model stone Stūpas in Behar there are nine. Proceeding to Burma, we find the process going still further. In a pagoda found in Pegu, the tee is very long, though the

Stūpa still remains in an attenuated form. But in another Burmese example hardly anything but the tee is left, the lower portion almost disappearing. Finally, we come to the last development in China, where the tee is practically all that is left.

I do not think it would be easy to find a more remarkable example of evolution in art. The process of development, when pictorially represented in its successive stages, almost resembles that of growth in the vegetable world. Here you have an Indian architectural ornament, consisting of a few superimposed umbrellas only a few feet high, finally transformed into a nine-roofed Chinese pagoda reaching the height of 200 feet. Fergusson, in his "History of Eastern Architecture," suggests that the Chinese pagoda is derived from the Stūpa, but he nowhere tries to prove the connection, though some of the illustrations in his own work supply part of the evidence. I hope the illustrations of the successive stages which I showed when reading this paper demonstrated the connection.

The Stūpa became, to the early Buddhist, *the* religious edifice. In the earliest sculptures we constantly find representations of it being adored by men, celestial beings, and even animals, such as elephants. It was also the sacred object always set up for worship in all the temples of early Buddhism in India.

This brings me to the second class of Buddhist religious buildings, the so-called Chaityas, which are the exact counterpart of Christian churches, not only in form, but in use. Till recently only rock-cut examples, to the number of about thirty, were known in India. These enable us to understand what the interiors, at least, of these structures were like. The existence of these rock-cut temples is a great advantage for the history of architecture in India, because they are still the same as when they were originally designed, some of them well over two thousand years ago, while the original form of far later structural temples is often quite obscured by modifications and additions.

The typical Chaitya consists of a nave and side aisles, terminating in an apse or semi-dome. The pillars separating the nave from the aisles are continued round the apse. Under the apse and in front of its pillars is the rock-cut Stūpa, nearly in the same position as that occupied by the altar in a Christian church. The tee was doubtless usually surmounted by a wooden umbrella, but this has everywhere disappeared except at Karli, the finest Chaitya cave in India. The wooden umbrella there was in quite a good state of preservation when I saw it in November, 1907. The roof of the Chaitya is semi-circular. The door is opposite the Stūpa. Over the doorway is a gallery. Above this is a large window shaped like a horse-shoe. This window is constantly repeated on the façade as an ornament.

The outward appearance of the structural Chaitya was for a long time somewhat conjectural, though one of the monolith Hindu temples, called the Seven Pagodas, near Madras, supplied the key; but some recent discoveries of ancient structural Chaityas in the Bombay and Madras Presidencies have confirmed these conjectures, especially as regards their wooden origin.

The excavation of these Chaityas extended from 260 B.C. to about 600 A.D., and the history of the development of their style can be followed step by step throughout these nine centuries. The oldest of them date from the time of Asoka, and are situated at Barābar in Behar, sixteen miles north of Gayā. The most important of them is called the Lomas Rishi Cave (the Cave of the Hairy Sage). The front is carved so as to represent in rock the form of the structural Chaityas of the age. The posts, the five rafters, and the blocks at the sides are all imitations of wood. The door has also the primitive feature of jambs sloping inwards, in imitation of wooden buildings. The hall inside has a semi-circular roof. It is adorned with no kind of ornament, but the granite surface of the rock is highly polished throughout. Beyond the hall there is an almost circular apartment. This is a remarkable feature, because it represents an experimental stage in rock-excavation. It is evidently an attempt to represent the shape of a Stūpa in the form of a hollow chamber, instead of, as in later excavations, leaving a mass of rock at the end of the nave to be carved into a solid Stūpa.

All the most important examples of Chaityas occur at six places in Western India. As we pass from the earliest to the latest specimens, we can clearly trace progress towards stone construction on the one hand, and degeneracy of cult on the other. In the oldest of these Western caves the pillars of the nave slope inwards, as in wooden structures, to resist the thrust of a circular roof. The rafters here, as well as the screen, were made of wood, but these have long since disappeared. In later specimens, the pillars of the nave and the

jambs of the door become straight, and the screen consists of rock.

At Ajanta there are four Chaityas. The second oldest of these shows a very interesting transition from wood to stone. For while the ribs of the vaulted roof of the nave were of wood, the ribs in the aisle are of stone, copied from wooden forms.

The third Chaitya at Ajanta (No. 19) is at least four centuries later, dating probably from the fifth century A.D. Here all trace of woodwork has disappeared, earlier wooden forms being everywhere reproduced in stone. The rail ornament so common in the earlier caves has vanished, while the horse-shoe window-heads employed as a decoration on the façade are dwarfed. A striking change is the fact that figure sculpture has superseded the plainer architectural forms of the earlier caves. The greatest change, however, is this. Buddha has now been introduced in all his attitudes. Only ordinary mortals are sculptured in the earlier caves, while Buddha never appears. Now he is even the object of worship, his image being placed in front of the Stūpa itself, which alone was adorned in the older Chaityas. In place of the atheism of the Buddhism of an earlier age, we find ourselves here confronted with an overwhelming idolatry.

In the last of the Ajanta Chaityas (No. 26) which dates from about 600 A.D., the sculptures are more mythological than in the previous cave, evidently approximating to the iconography of Brahmanism.

We now come to the caves of Ellora, which are particularly interesting from a comparative point of view, because here we find Buddhist, Jain, and Brahman temples side by side, while the Ajanta caves are exclusively Buddhist. The large Buddhist Chaitya here appears to be of about the same age as the latest example at Ajanta, *i.e.*, somewhere about 600 A.D.

The evidence of lateness here is very manifest. The great horse-shoe opening is for the first time absent in the façade. Instead of it we find a small upper window, a reminiscence of the horse-shoe, with a lower and wider window, divided by two pillars, below. The end of the nave is entirely blocked by the Stūpa. The Stūpa itself, instead of being circular, has a frontispiece which makes it square on this side. This addition has a figure of Buddha seated with his feet down, and surrounded with attendants and flying figures in the latest style of Buddhist art.

Finally, we have at a place called Kholvi what is probably the latest Buddhist Chaitya cave in India. The Stūpa which it contains is no longer solid, but is hollowed out into a cell in which an image of Buddha is placed. This marks the last step in the development of the Buddhist temple. A link connecting this formal stage with the later Jain and Hindu temples is to be found in an old structural Vishnu temple dating from about 700 A.D. Here the Stūpa is superseded by a cell for the image, but this cell still has a semi-circular back and is separated from the outer wall by a passage for circumambulation, which is a continuation of the aisles as in the Buddhist Chaitya. The transition is completed by the next step when the cell is made square. This is the case at Pattadkal in an early Hindu temple, which is otherwise the same in plan as the one I have just described.

The development of the Buddhist temples which I have just traced will show you, I think, how important archæological evidence is for the history of Indian religion as well as architecture and sculpture. Showing how the Buddhist religion gradually became idolatrous and approximated more and more to Hinduism, it makes us understand how that religion could die of inanition in India in face of the revival of Hinduism, which had absorbed much of the ethical teaching of Buddhism, and had even come to acknowledge Buddha as one of the ten Avatars of Vishnu. Thus Buddhism, which had originally emerged from the older Brahmanism, again relapsed in India, after more than 1,000 years, into a later form of the same religion.

Besides the structural Stūpas or their substitutes, the rock-cut temples, there arose Vihāras or monasteries, as residences for Buddhist monks. Our knowledge of these is still more dependent than in the case of Chaityas, on the rock-cut examples. There are about nine hundred Buddhist caves of this class in India, besides about one hundred belonging to the Jain and Brahman religions. According to the rock-cut specimens, the Vihāras consisted of a hall (sālā), generally square, but sometimes oblong, surrounded by a number of cells or sleeping cubicles, and shaded by a verandah in front. The cubicles in the oldest caves usually contain a stone bed. There is generally only a single floor, but examples of two-storeyed Vihāras are not wanting. The only examples of Vihāras in Eastern India are found at Udayagiri, in Orissa.

All the rest are found in Western India. Probably about forty of these were excavated

before the Christian era. The four most important of these occur, one each at Bhājā and Bedsa, and two at Ajanta. That at Bedsa is specially interesting because the Vihāra here has an apse, which points to this being a first attempt to excavate a Vihāra in rock, as it imitates the shape of a Chaitya. The interior of Vihāra (No. 12) at Ajanta, is adorned with seven horseshoe arches, four over the doorways of cells, while three are simply ornamental.

The second of the early Ajanta Vihāras dating from about the end of the first century B.C., is a transitional example. For here we first meet with a Vihāra ceiling supported by pillars in the centre. These are four in number. It is to be noted that in all these early Western Vihāras there is no figure sculpture, no reliefs, no carved emblems even. The only ornament consists of horse-shoe arches and the Buddhist rail as a string course, with an occasional pilaster.

In the Vihāras of the second period a further step is taken in construction. The number of pillars supporting the roof is increased to 12, which are arranged as a square with four on each side. This advance is always accompanied by the degenerate feature of a sanctuary containing an image of Buddha being introduced in the back wall. The next step was to increase the number of pillars to 20, then 24, and finally 28.

Nasik and Ajanta are the most interesting places for the study of Vihāras, the groups of caves in both places being purely Buddhistic. One of the principal ones (No. 3) at Nasik has a verandah with Persepolitan pillars. It has a hall 40 feet square, without pillars, and contains 16 cells. In the middle of the back wall is added the new feature of a Stūpa carved in relief.

There is at Nasik another and larger Vihāra which has the still later addition, at the inner end, of a sanctuary with two richly carved pillars in front and containing within it a colossal seated Buddha with flying and standing attendants, doorkeepers, dwarfs and so forth, such as are not found till in the fifth century.

Ajanta has more Buddhist Vihāras than any other place, the number being twenty-two. These are specially important as supplying a complete series of examples of Buddhist art, without any admixture from Hinduism or any other religion, extending from 200 B.C. to 600 A.D., and thus belonging to all three periods. As they contain many inscriptions the dates of the caves are fairly well known, and thus help to fix the chronology of other groups.

The caves of Ellora are, however, the historically most interesting with reference to the inter-relation of the three Indian religions, Buddhism, Brahmanism, and Jainism. For here we have side by side three groups of caves (altogether thirty-three), distinctly representing those religions, while the transitions from one to the other can be clearly traced. Of the Buddhist group of twelve, eleven are Vihāras. The sanctuaries of most of these contain figures of Buddha seated, but with the feet down and not folded under them. Thus, the Buddhist monastery is becoming a place of worship in which figures of Buddha are ousting the monks from their cells. These Vihāras come down to about 700 A.D., at which point the earliest Brahman examples begin. There are here three two-storeyed caves which illustrate clearly the transition from Buddhism to Brahmanism. The first is entirely and unmistakably Buddhist. The second is similar in plan, and the sculptures are still all Buddhist, but these deviate sufficiently from the usual simplicity to have justified the Brahmans in appropriating this cave as belonging to their religion. The third is very similar in plan to the preceding one, but the sculptures are all unmistakably Brahman. It is evidently the earliest Brahman cave, being a close copy of the preceding Buddhist example.

We have thus arrived at the beginning of the Hindu period of Indian architecture. We have seen that the Buddhists were the first builders and carvers in stone in India, beginning in the third century B.C. It is only on Buddhist monuments that we find the earliest representations of Hindu deities. Thus Lakshmī, the Hindu goddess of Fortune, worshipped by two elephants pouring water over her, appears on Buddhist sculptures from the second century B.C. onwards. But the oldest remains of independent Hindu art, either sculptural or architectural, only date from several centuries after the beginning of our era. These considerations in themselves justify the presumption that Hindu architecture is derived from the older art of the Buddhists. This presumption is borne out by the fact that the earliest extant Hindu samples are, as I have just shown, practically identical in form with the latest Buddhist specimens, differing from these latter only in having the image of a Hindu deity,

instead of one of Buddha, placed in the shrine. Again, at Ellora, some of the sculptures in the earliest Hindu cave temples are hardly distinguishable from those of the latest Buddhist caves at that place.

The whole surface of India is covered with Hindu temples, the vast majority quite modern or comparatively modern. The number of ancient shrines is small, chiefly in consequence of the destructive religious fury of the Mohammedans, who invaded India from 1000 A.D. onwards. The oldest specimens date from about 600 A.D., and the best examples are to be found between that date and 1300 A.D. In surveying these ancient monuments we can clearly distinguish two styles, each of which shows a definite type from the beginning. The geographical distribution of these two types is, to begin with, rather interesting. For the Southern or Dravidian style of Hindu architecture is found only within the tropics, or south of the 23rd degree of northern latitude. The Northern or Indo-Aryan style, on the other hand, is found only north of the tropic of Cancer, excepting only the eastern and western extremities of its territory, which come down to the 20th degree. A historical study of these two, moreover, shows that the Hindu temples of both styles are developments of Buddhist prototypes. But the remarkable thing is that they are respectively the descendants of two entirely distinct classes of Buddhist building; for it can be shown that the Dravidian Hindu temple has been evolved from the Buddhist monastery, while the Indo-Aryan Hindu temple has been developed from one of the other two classes of Buddhist building.

I will deal with the Dravidian temple first. The earliest representative of this type is a temple at Mahābalipur, one of the Seven Pagodas, situated near the seashore, 35 miles south of Madras. It is a monolith, being hewn out of a single block of granite, and dates from about 600 A.D. It is clearly Brahmanic in origin, as is shown by the sculpture as well as the inscriptions. But it is evidently also a model of a Buddhist monastery of four stories. The plan is square, the pyramidal tower representing the upper storeys containing the cells of the monks. The design of the regular structural Dravidian temple is a square base ornamented externally with pilasters, and containing the cell in which the image is kept. Over the shrine rises the sikhara, a pyramidal tower, which is always divided into storeys. This division never disappears in Dravidian temples. The tower is crowned with a small dome, either circular or polygonal in shape.

An early example of the Dravidian style of Hindu temple on a grand scale is the Kailāsa, at Ellora, which dates from the seventh century A.D. This also is a monolith, but on an enormous scale. It is, really, one of the wonders of the world, for it is a temple carved elaborately inside and outside, out of a single huge rock left standing after a wide passage had been cut away in the hill side around it. Out of this living rock were cut shrines, porches, columns, halls, steps, galleries, roofs, and the most detailed sculptures 1,300 years ago. Much of the sculpture is still as clear as when it was first carved. It would take a large volume to illustrate fully the details of this marvellous structure. It is the culmination of the art of rock-cutting in India.

In front of the Dravidian temple a porch, or even two porches, may be added, but these are not an essential feature of the building.

The later Dravidian temples from about 1000 A.D. stand in a large court surrounded by an enclosing wall. A special feature here is the Gopuram, or great gateway, erected in front of the shrine in the wall which encloses the court around the temple. It has a storeyed tower, resembling that of the shrine itself. But it is oblong, not square, in shape, being twice as wide as it is deep. The prototype of these gateways is the oblong monolith temple at Mahābalipur, one of the Seven Pagodas. It is in storeys, with a waggon-headed top, the ridge being decorated with a row of ornamental vases. These have all fallen from the roof, but the bases can still be seen. The best specimen of the structural temple in the Dravidian style is that at Tanjore, which was erected in 1025 A.D. The body of this temple is of two storeys, about 80 feet high, while the pyramidal tower rises in eleven storeys to a total height of 190 feet.

Many of the famous later temples of Southern India are architecturally a good deal spoilt by two main defects. In the first place, successive independent additions obscure the design of the original shrine, producing a sense of bewilderment in the observer, who is unable to discover any general plan or arrangement of parts. The second defect of these later temples is the fact that the gateways in the walls of the successive courts, which have subsequently been added, increase in size and height as you proceed outwards, thus entirely obscuring the tower of the central shrine.

Both defects are specially striking in the Srirangam temple, near Trichinopoly, which is the largest in India. Here there is a fifth court which was added, but left unfinished, in the middle of the eighteenth century. The shrine itself is quite insignificant, being distinguishable only by the gilding of its dome, while the Gopurams of every court are each larger and more decorative than the preceding. Another temple in which these defects are conspicuous, though not to so excessive an extent, is the great temple at Madura. There is a fine group of earlier Hindu temples dating from the ninth century A.D., in the Dravidian style, at a junction called Gadag on the way between Poona and Bangalore. They are conspicuous for the elaborate carving, both without and within. One of them is dedicated to Sarasvatī. The finest part of it is the porch, which contains some exquisitely carved pillars. Inside the cell is a figure of Sarasvatī, goddess of learning. It is very difficult to obtain successful photographs of such images owing to the darkness of the shrine, which is lighted through a small doorway only, and is at the back of the porch. The carving on the lintels and the architrave of this particular doorway is beyond description: no chased work in silver or gold could possibly be finer. There is also a Vishnuite temple here, with a Gopuram of four storeys, and 50 feet high.

About 60 miles from Gadag is situated a place which is virtually a vast open-air museum of Hindu monuments in the Dravidian style. This is Vijayanagar, the ruined capital of a Hindu kingdom, which was founded in 1118, and remained a bulwark against Mohammedan invasion for two centuries and a half. The city was at last captured in 1565, and has remained deserted ever since. The ruins of palaces and temples cover an area of several miles. The travellers' bungalow itself, in which I slept, was an old Hindu temple. The finest temple here is that of Vittoba Svāmi, a form of Vishnu, erected soon after 1500 A.D. This, together with two other shrines, is surrounded by an enclosure with four Gopurams. The finest part of the main shrine is the porch, which is notable for its elaborate composite pillars and columns with richly carved figures of conventionalised animals attached to them in front. Close to this temple is to be seen in the court the stone car of the god, 26 feet high, carved out of a single block of granite. The stone used in all the buildings at Vijayanagar is granite, and the enormous size of the slabs used is very remarkable. A walk of rather over a mile brings one to the great temple of Siva (under the name of Pampāpati Svāmi). This temple is in use, as there is a small village called Hampi close to it. It has a great Gopuram at the north entrance. Taken in all its dimensions (being over 165 feet high) this gateway is, perhaps, the largest in India. A few hundred yards from this great temple are two vastly solid shrines, built of granite, of the elephant-headed god Ganesa, containing idols of that deity, one 10 feet and the other 18 feet high. There are many other interesting ancient monuments on this vast site, but it is impossible for me to dwell on them any longer.

To each of the great temples of Southern India is attached a large tank for the religious ablutions of the worshippers. Some of them are picturesque, such as that in the great temple at Srīrangam, near Trichinopoly. Sacred tanks not within the precincts of a temple are also frequent in Southern India. These are called Teppa kulam, or raft tanks, with a small shrine in the centre, to which at certain festivals the image of the god is taken across on a raft. There is a great Teppa kulam at Madura, in which the central island is adorned with a pyramidal Dravidian tower in the middle and four small pavilions at the corners.

One of the features of the Madura and other great South Indian temples are the colonnades which surround the tanks. In the colonnade of the Madura temple I witnessed the recitation of the Mahābhārata, the great Sanskrit epic, which is a kind of moral encyclopædia to the Hindu. Each Sanskrit verse was expounded in Tamil by the Brahman reciter to the crowd of natives who squatted around him. Other South Indian temples have colonnades around their court. This is the case in the great Siva temple at Vellore, not far from Madras. It is one of the most remarkable shrines in South India. It has a Gopuram, seven-storeyed, and 100 feet high. The colonnade which runs round the enclosure, is supported by nearly 100 carved pillars. There is a remarkable stone pavilion in the left hand corner of the enclosure as you enter, the ceiling and the pillars being most exquisitely carved.

Here I must add a few words about the columns of the South Indian style. The early Dravidian temples had conventional lions and elephants of normal shape as supports of their pillars. These were gradually enlarged and affixed to the

pillars, as at Madura; the animal forms being conventionalised with riders. Human and other figures were then introduced as supporters, for example, in the Srīrangam temple, near Trichinopoly, where the ornament becomes altogether excessive.

One of the most sacred shrines of India, which has been for centuries the goal of pilgrimages from all parts of India, is the great temple of Rāmesvara, sacred to Rāma, situated on an island close to the mainland, in the channel between South India and Ceylon. It has a magnificent Gopuram. Its most striking feature, however, is the wonderful corridors which adorn it. The south corridor is 700 feet in length, that is to say, it is the longest in the world excepting that in the Vatican.

A variety of the Dravidian style is that which has been called the Chālukyan by Fergusson, after the dynasty which ruled from about 400 A.D. onwards in the territory where this variety prevails. It embraces the northern and the north-western part of the region covered by the southern style of architecture. The peculiarities of this style are these. The ground plan is star-shaped, and the tower is stepped rather than storeyed, forming a square pyramid with breaks corresponding to the angles in the walls. The temples generally stand on a terrace from 10 feet to 15 feet wide, and 3 feet to 6 feet high, a feature which adds very greatly to their architectural effect. The best examples belong to the period between 1120 and 1270 A.D. The most perfectly preserved example is the temple of Somnāthpur, about twenty miles from Mysore city. The buildings were erected without mortar, the joints being carefully fitted. The details of this style are very elaborate, most of the finer temples being overlaid with sculptural ornament, consisting of floral patterns intermixed with mythological figures. Another fine Chālukyan temple is that at Belur, dating from 1120 A.D., and situated in a remote part of the State of Mysore. In it may be seen the best specimens of the perforated stone windows which are one of the special features of this style.

But the most attractive of all the Chālukyan shrines is the great temple of Siva at Halebīd, about twenty miles from Belur, delightfully situated on a terrace near the shores of a lake. It was left unfinished in the year 1270 A.D., the towers never having been added. It is one of the most remarkable monuments in India. One of the pavilions in front contains a huge image of the Bull of Siva. In the interior are some remarkable black stone pillars, which look as if they had been turned in a lathe. This temple is unmatched in the variety of its details and the exuberance of fancy shown in its ornamentation. There is, perhaps, no other temple in the world on the outside carving of which such a marvellous amount of labour has been spent. It will give some idea of the enormous amount of sculpture with which this temple is covered when I mention the fact that the lowest band of the frieze alone contains a procession of about 2,000 elephants, no two of which exactly resemble each other.

Now let us turn to the Indo-Aryan style of Hindu architecture. By great good fortune there are extant side by side two of the earliest examples of the Dravidian and Indo-Aryan styles near a place called Badāmi, in the Chālukyan territory. They date from the end of the sixth century A.D., and already show fully developed the characteristic features which the two styles clearly retain down to the present day. Both have a square base containing the cell, but while the Dravidian temple has a pyramidal tower, always divided horizontally into storeys, the Northern tower is a curvilinear spire, not divided into horizontal storeys, but, on the contrary, having a vertical band running up each face. While the Dravidian tower is surmounted by a small round or polygonal dome, the Indo-Aryan tower is surmounted by a circular fluted ornament, somewhat flattened at the top. The Indo-Aryan, like the Dravidian shrine, has a porch nearly always added in front of the entrance to the cell, but it was evidently not essential, not being an integral part of the edifice. The shrine itself consists of two parts. The lower part containing the cell is square. It rises from a moulded plinth and ends in a cornice. There are never any pillars or pilasters (as in the lower part of the Dravidian shrine). Above this rises the spire, which is square in section, and the curve of which in the early specimens begins near the top. The central vertical band was carved, usually with a reticulated ornament composed of minute arches.

The Mandapam, or porch, is added in front of the doorway of the cell, and is square, being of the same height as the top of the shrine where the spire begins. In the earliest specimens there were no pillars, and the roofs consisted of long sloping slabs. Later, columns were introduced in groups of four, and courses of masonry were made outside to correspond to the carved conical roof inside.

The earliest representatives of the Indo-

Aryan style are found in the group of deserted Hindu temples at Bhuvanesvar in Orissa, about 250 miles south of Calcutta. The older and finer specimens begin from about 600 A.D., the series coming down to about 1100 A.D. They show this style in its greatest purity, and probably furnish better material for the history of this form of Hindu art than any other temples in India.

To the ninth century belongs the celebrated Black Pagoda, a temple of the Sun, at Konārak, in Orissa, about 20 miles from Purī, and within sight of the sea. It represents the car of the Sun drawn by seven horses, with twelve gigantic, elaborately carved wheels of stone on each side. For its size, it is, on the outside at least, the most richly ornamented building in the world. There are several figures of the Sun-god carved on the outside.

Next in chronological order comes the large group of Hindu temples at Khajrāho in Central India, dating from between 900 and 1200 A.D. The older ones are covered, inside and outside, with the most elaborate sculptures. They are shrines of either Vishnu or Siva. This is, on the whole, probably the finest group of temples in India. A feature in the evolution of this style is that the number of porches is gradually increased to four.

The famous shrine of Jagannāth, the lord of the world, a name of Vishnu, was erected about the year 1200 A.D. Within its enclosing wall, which is about 20 feet high, are crowded together something like 130 shrines. Purī is a great place of pilgrimage from all parts of India, but the great crowd of pilgrims assembles at the car festival in June and July. The great car, which is 45 feet high and 35 feet square, is then, with the image of the god placed on it, dragged from the temple to the garden house of the god, situated at a distance of about a mile. In pulling the great car and two lesser cars along, a throng of more than 4,000 professionals are employed. After the festival, these wooden cars are broken up and the fragments distributed to pilgrims. Purī was in all likelihood the original place where the famous tooth relic of Buddha was worshipped in very early times, and there are various facts connected with the temple which point to a Buddhist background. Thus when pilgrims eat the sacred food within the precincts of the temple, all caste distinctions disappear. The highest Brahman would then take food from the hands of a man of the very lowest caste: a thing otherwise impossible in India.

The origin of the Indo-Aryan spire has always been a puzzle to Eastern archæologists. Thus Fergusson, the great authority on the subject of Eastern architecture (p. 412) says:—"Neither the pyramid nor the tumulus affords any suggestion as to the origin of the form, nor the tower, either square or circular; nor does any form of civil or domestic architecture. It does not seem to be derived from any of these." Here, then, we are faced with a fascinating problem. We have already seen that the Indo-Aryan Hindu spire appears fully developed in its earliest occurrence, about 600 A.D., beside the Dravidian Hindu pyramidal tower. It has clearly no connection with that tower. But it can still less be a development of the Buddhist Chaitya or church, with its wagon-headed roof and semicircular apse at the end, which shows no suggestion of anything like a spire about it. Where then are we to look for its source? I believe the answer can be given with certainty, or at least a high degree of probability; and although I cannot here adduce all the evidence, I think I can supply enough to establish the correctness of the conclusion. I have shown how the Buddhist Stūpa in the cave temples gradually developed from a plain solid dome into an elongated hollow cell containing an image of Buddha. The transition from the solid to the hollow Stūpa is further illustrated by model Stūpas at Bodh Gayā. Then we find near Badāmi an old structural Hindu temple of Vishnu dating from the seventh century A.D., containing a similar hollow cell for the image, the back of the cell being still semi-circular. In that neighbourhood we find another old Hindu temple, the same in other respects, the only difference being that the cell has become square. Now, there are to be found in Northern India a number of simple Indo-Aryan shrines erected without porches. These evidently bear a strong resemblance to the transformed hollow Stūpa. In place of the original round drum you have the square base, as more suitable in form for a cell. Above this rises the spire in place of the elongated dome, and still retaining the vertical curve of the latter, but modifying its circular shape by carrying the corners of the square base to the top. Thus the horizontal section of the spire becomes square also.

Finally comes the explanation of the ornament at the top of the spire. I think we may dismiss the theory that the fluting is an imitation of a certain small Indian fruit. In the earliest examples of Indo-Aryan temples there

is a neck between the top of the spire and the ornament. One of the rock-cut Stūpas at Ellora indicates that the neck represents the lowest part of the tee, and the ornament above represents the upper part, the fluting being a rounded modification of the vertical divisions in the tee. The curved flattened top probably represents a single umbrella. In one of the rock-cut Stūpas at Ajanta, the three umbrellas carved in stone above the tee are themselves fluted. These in turn are surmounted by the vase-shaped finial which regularly appears at the top of the Indo-Aryan spire.

Thus we arrive at the remarkable conclusion that, while the Southern Hindu temple has been evolved from the Buddhist monastery, not only Buddhist temple architecture outside India, but also Hindu temple architecture throughout Northern India, is a development of the Buddhist Stūpa. In the Northern Hindu temple the dome of the Stūpa was elongated, while the umbrella ornament became attenuated. Outside India the dome was gradually attenuated till it finally disappeared, while the umbrella ornament grew to such an extent that it finally became a tower 200 feet in height. With the red thread of historical study to guide us, we are thus enabled to understand clearly what otherwise presents itself as an inexplicable mass of disconnected phenomena in the domain of early Indian architecture.

DISCUSSION.

The CHAIRMAN (Sir Richard Temple, Bart., C.I.E.), in opening the discussion, said he was sure all present would agree with him in congratulating the reader of the paper on the illuminating address he had delivered. As time was exceedingly short, he proposed to limit himself to one or two points which were of special interest to him, the first being the author's description of the development of the form of the Stupa into the modern Far Eastern pagoda. About 20 years ago, he (the Chairman) lectured upon that subject at the Royal Anthropological Institute, referring to the identical points that the author had mentioned; and he was glad to be able to support Prof. Macdonell in his statement that the modern pagoda arose out of the elongated tee of the original Stupa. But in his lecture he added another point, namely, that there was a double elongation. There was in the Indian pagodas what was called the aonla, or amalaka, ornament, and the present form of the Burmese pagoda was an elongation of both the tee and that aonla ornament. He was also able to show n that lect ure that the many-storeyed and roofed buildings of China were developments of the tee. His lecture was never published, owing to his not fulfilling the promise he made at the time that it should be; but he still had the paper, and it would be a great pleasure to him to hand it over to Prof. Macdonell, if it would be of any use to him in the book which they all hoped would come out of the paper. The author mentioned another point of great interest to those who had had to study Buddhist architecture in the Far East, when he stated, in describing the caves of Ellora, that the Buddhist monastery became a place of worship in which the figures of Buddha were ousting monks from their cells. That remark, he thought, illustrated the existence of certain well-known rock sculptures, opposite Prome, in Burma, which otherwise seemed to have no meaning at all, and it also explained the ornamentation of the caves in Southern Burma, both inside and outside, which consisted of a large number of very small shrines with nothing but the Buddha in them. It was very interesting to think that that ornamentation was originated by the monk in his cell. There was an elaborate paper by himself on that particular point in the "Indian Antiquary" of about fifteen years ago, called "The Antiquities of Ramannadesa," which meant the lower districts of Burma, Rangoon, and so on. The most valuable part of the paper was that in which the author showed that the modern Hindu architecture, both northern and southern, arose out of the Buddhist architecture. That was new to him (the Chairman), and, he believed, to most of those present, and it would be extremely interesting to see how that subject would be followed up.

Sir GEORGE WATT, C.I.E., M.B., LL.D., having thanked the author for the admirable paper he had delivered, said he had always felt that a mistake had been made by some writers on the subject. They started, as the author had done, with Buddhism, but he had a strong conviction that they might go back a good deal further, and perhaps the defect of the paper was in that direction. If the author had gone up into the hills, and studied the aboriginal temples which were everywhere to be seen, he thought he would have recognised the prototype of a good many of the Buddhist monuments. He was quite aware that the Buddhists were the first people to use stone, who excavated temples, and later on built them; hence writers on this subject could not help themselves very well in dealing with the Buddhists, because all the older temples had necessarily disappeared, having been made of wood. But he thought we were justified in looking at the temples that existed, although they were recent, in order to see whether from them we could get any conception of the source whence the Buddhists derived their great conception. As the author said, the Chaitya exactly represented a portion of a Christian church. The processional passage was an exceedingly important feature of most Buddhist monuments. It would be in-

teresting to know where they got their conception of a church (Chaitya, or assembly-hall), consisting of three galleries, a central nave and two side aisles. It suddenly appeared in the great temples at Ajanta, Karli, and Ellora, but where did it come from? Personally he thought it came from a former religion and architecture, and that previous architecture was, in his mind, present in the little temples that one saw everywhere throughout India. By looking at the temple at Simla, near the brewery, one might regard it as the prototype of the great and wonderful Buddhist architecture. It consisted of a hall with a double-angled roof and pillars supporting the bent roof, and dividing the whole into three sections, a central nave and two aisles. Going to the end, it would be found that over the temple there was placed a curious box-like structure, and over that was thrown an umbrella, exactly like the tee to which the author had referred. He thought a mistake was often made in regarding the Aryans, the Nature-worshippers who invaded India, as having necessarily founded all the Hindu religion, architecture, and arts. He believed that, while the Aryans were in India and were Nature-worshippers, they needed neither idols nor temples, but he did not think that that of necessity involved that there were no temples and no idols before the Aryan conquests. He believed, at all events, that many of the temples he spoke of had idols, some were very beautiful, but they were not Hindu or Buddhist. It was known, as a matter of fact, that when the Aryan faith began to degenerate, it did so by absorbing the aboriginal faiths, some of which still lived. The author alluded to a carving of Lakshmi, the goddess of Fortune, with the elephants pouring water over it. That sculpture went back to perhaps to 150 B.C., and if it was a Hindu idol it was, perhaps, the oldest one known.*

Mr. R. SEWELL said he found himself in cordial agreement with the author on almost every point upon which he had touched. The author had referred to the origin of South Indian architecture lying in the Buddhist Chaitya, while the Northern architecture was derived from the Buddhist Vihara. The Vihara in the Buddhist stone sculptures was undoubtedly derived from wooden forms, showing, in successive storeys, terraces surrounded by the cells for the monks. Those cells could be traced century after century through the entire range of Hindu architecture down to the present day. The earliest specimens, in South India, with which he was acquainted were at the Seven Pagodas, and at Conjeveram where, on the terraces of the low square towers, the cells were quite separated from one another, each storey being distinctly smaller than the one below it. A little later, the whole structure became a low tower, the cells joining one another and forming a wall; gradually, as years went on, the tower increased in height, and the storeys were joined, the upper to the lower. The tower then became a structure of great height, on a small base, still bearing the representation of the old cells, but in very low relief.

Colonel T. H. HENDLEY, C.I.E., desired to enquire of Sir George Watt whether many of the pagodas in the hills were not forced upon the hill people by the Nepalese, and, therefore, whether they were not, to a certain extent, Buddhist, having been derived from the architecture of the plains. It was, no doubt, well-known that constant repetition of old forms went on from age to age, and that the wooden structures in the hills might represent some aboriginal type. He was not sure, however, that it could be argued from that that the aborigines had constructed buildings, which were not of the rudest character, in any part of India, and still less so in the hills. The photographs the author had shown recalled to his mind the fact that in and about Jaipur in Rajputana there were temples of all kinds in the styles of South India, Bengal, or even the hills, which owed their origin to architects of patrons whose business or pilgrimage had made them familiar with distant places. In this way some confusion of styles occurred. He wished to ask the author also whether he had referred sufficiently to the Jains. Did he think their architecture was derived from the Buddhists, or was peculiar to them, seeing that it was generally held that their faith was as old as, if not older than, that of Buddha? He agreed with the Chairman that there had been a gradual development from age to age, and, as an example, reminded the author of the famous Jain tower, dating from the ninth century of our era, in the Chittur Hill, which had undoubtedly served as a model for the still more beautiful structure not far from it—namely, the Tower of Fame of Rana Kambhu, which was erected in the fifteenth century.

The CHAIRMAN said that, on behalf of himself and other humble students of the particuler subject under discussion and of Buddhism, he wished to reply shortly to Sir George Watt's remarks. Had he thought there would have been sufficient time, he would have brought out the point that, in the earliest Buddhist sculptures which were known, they had not by any means reached the beginning of things, because the sculpture showed such an immense advance in art that there must be a long history before them. He did not know that the writers upon that particular point had made a mistake in supposing that there was not an aboriginal origin, at any rate in part, for Buddhism, because a year or two ago he produced quite an elaborate book showing that Buddhism had, to a very considerable extent, arisen out of the beliefs of the people, but that those beliefs were not what was now known as modern Hinduism.

Professor MACDONELL, in reply, said he was very glad to hear that the Chairman had so much material in his possession which would corroborate some of

* See also the letter from Sir George Watt on p. 328.

the conclusions to which he (the speaker) had come with regard to the origin of the pagoda, especially details with which he was not acquainted. With regard to the question of the origin of Buddhist architecture, he thought there must be a great deal that was based on pre-Buddhistic or aboriginal sources. For instance, it could probably be shown that the wagon-headed Chaityas had been constructed in imitation of aboriginal thatched wooden buildings which still existed in India. There was a description, in a book called "Glimpses of India," of such native buildings somewhere in the South, which were almost exactly like Chaityas in shape. With regard to the question of the use of idols, he thought it was highly probable that idolatry prevailed extensively in ancient India among the aborigines, but it was very difficult to believe that the very primitive idols which existed could have exercised any influence on the highly-artistic sculptured images of Buddhism. As far as the evidence went, these were all started by the Græco-Buddhistic art of the North-West, from which it spread to every other part of India, and to the rest of the Buddhistic world. Very likely the aboriginal worship of idols encouraged the use of images in Buddhism, which originally rejected all worship of idols. Nevertheless Buddha afterwards became deified himself, and was one of the most frequent idols to be found anywhere. He thought it was important to try to discover what aboriginal influence had taken place in Buddhism and Hinduism, which was one of the difficulties of the study of those religions. It was known, for instance, that Hinduism had absorbed a great deal from aboriginal religions, such as that of snake worship, which the Aryans appeared not to have known in the earliest times. Another example was Linga worship. He quite agreed with Sir George Watt that it was important to study that aspect, and not to suppose that Buddhist art started from a *tabula rasa*. He thought the Jain temple architecture could be shown to be a development of Hindu and not of Buddhist architecture. The Western Jain style was altogether based on the Northern or Indo-Aryan style. The porch was the special development which had separated the Jain architecture from the ordinary Indo-Aryan style, but the tower which was used in Jain temples above the cell was still Indo-Aryan. It was difficult to treat these questions in a connected way without having thought them out first, so that he would rather not make any furthur remarks at the present time.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to the author for his valuable paper, and the meeting terminated.

Sir GEORGE WATT writes:—

When I was called upon to speak, the other day, on Professor Macdonell's suggestive and interesting paper on "The Buddhist and Hindu Architecture of India," there was a feeling clearly shown by the audience that no time had been left for discussion. In consequence I felt that I could only venture to speak for a very few minutes, and I am afraid what I did say but very imperfectly conveyed my meaning. Perhaps, therefore, I may be permitted to amplify my observations by this letter.

In the first place, I think that a mistake may be made by writers on Buddhist architecture when they assume that we are not justified in going further back than to the time when the existing Stupas and cave temples were constructed or excavated. I admit at once that we can point to no actual existing monuments of a pre-Buddhistic period. But is that indispensable? Professor Macdonell says:—"In the pre-Buddhistic phase of Indian religion, from which Hinduism is directly descended, carved images of the gods and temples for worship were equally unknown. It is hardly to be expected that the very rudimentary art of that early age should have attempted to represent in an anthropomorphic form gods which were still felt to be the deifications of natural phenomena, such as sun, fire, sky, wind. And in the absence of images architectural places of worship would not be wanted."

To investigate the issues there raised, however, it seems quite beside the point to discuss the religion of the Rig-veda or of the Yajur-veda, since we are, so far as the Vedas are concerned, interested in the time when the Atharvan was written—the Veda of the Magadha—if not of the Brahmanas. The religion there set forth may, I think, be spoken of as a combination of a degraded Nature worship taken from the early Vedas with the idolatry of the aborigines—Brahmanism. The old pantheon had been extended by the admission of earthly gods, spirits, and demons. In other words, with the Brahmanical elaborations of cults came sectarian gods, until, as Dr. Hopkins says, man had subdued the gods and himself become God. For the mass of the people the future was hopeless; the misery of other existences could alone be mitigated by sacrifice. Thus it may be truly said that the time was ripe for revolt, and two schisms appeared—Buddhism and Jainism. The former took its birth in the lower Himalaya, skirting Oudh, and attained its complete conception in Bihar. It seems thus a little unsafe to assume the absence of images and temples in the period when Buddhism appeared.

As a matter of fact, the Stupas, with their rails and gateways, are often richly decorated, both by scenes from the domestic life of the people of India 2,000 years ago and by symbols that must be accepted as denoting some features, at least, of the irreligion. The similarity of the Stupas of the Jains with those of the Buddhists is, moreover, a point of great interest, indicating very possibly that the conception of relic worship came to both schisms from an early and common faith. Thus, for example, the Sanchi gateway (which probably dates from 150 B.C.), gives us a vivid representation of *Lakshmi* (the Goddess of Wealth, and in late mythology a consort of Vishnu). All over that wonderfully interesting

monument there are other symbols of a very remarkable kind. The *dagaba* (*Stupa* or relic chamber), the *chakra* (or wheel, *dharma*, or book of the law), and *sangha* (the tree or congregation—the brotherhood) are in profusion. And these have been identified by some writers on this subject as the symbols of the trinity of Buddhism. So again the serpent (more especially at Amarāvati) appears not infrequently and has been accepted as an emblem of Buddha, though a five-headed cobra is in very general association with Vishnu. Lastly, we have the trident (*trisul*) shown in the most prominent fashion, a symbol which by certain Hindus is supposed to belong to Vishnu. Before rejecting these and other such symbols as having come into Buddhism from pre-existing faiths, one would like to obtain direct evidence of their having been invented and authorised to portray specific doctrines of the Buddhism as preached by its founder.

But the contrast between Sanchi and Ajanta is, to say the least of it, very striking. There is an infinitely closer resemblance between the remains of the Jaina rail at Muttra and that of Sanchi than can be traced anywhere in connection with the Chaitya and Virhara excavations. But for the fact that the Stupa and its rail have become sacred emblems, the symbolism of Sanchi and of all the other topes may be said to have been entirely discontined with the appearance of the assembly halls and monasteries, excavated out of the rock. Can this be viewed as a reformation in the faith (the rejection of all trace of early idolatry), and the birth of the complete conception of Buddhist atheism? Whatever it means, the change which took place had a most remarkable influence on Buddhist art and architecture. The Stupa was placed within the assembly-hall, the processional path around and behind the Stupa, or altar, gave origin very possibly to the aisles and apse, while the nave became the place for the brotherhood of monks, who conducted the service, just as may be seen to this day in the Lamasaries of Sikkim.

Thus it may be said the symbolic faith, portrayed on Sanchi, gives the impression, not so much of the birth of a new religion and of new art inspirations, as the mortuary of ancient aspirations. In other words, the transition from the sepulchral atmosphere of Sanchi to the vigour of silent Ajanta, leaves the impression of a chronicle of pre-Buddhist traditions and beliefs combined with the childhood of a new faith. These are contrasted with the manhood, decline, and death, shown at Ajanta —a university one might call it—of that new faith, Buddhism. So again the last stages, as recorded in India, mark the return to aboriginal beliefs, the reversion from an impersonal and abstract spirituality to a personal deity.

But I have trespassed far beyond the space that can be afforded me. I had intended to discuss in the second place, the impression of architecture conveyed to the mind by a study of the Buddhist monuments of India. The sudden appearance of the Chaityas is, perhaps, one of the most surprising features of this subject. Where did that conception come from? It points very conclusively to a knowledge having existed in the construction of assembly hall in wood, for many centuries prior to the idea having been obtained of the desirability of excavating these out of the solid rock. I repeat the suggestion made by Fergusson that it seems likely some of the primitive hill temples, in the country adjacent to where Buddhism originated, may preserve to us the original conception. I believe this is so, but (be that as it may) the skill that excavated such temples as Karléi can hardly be described as a "very rudimentary art," whatever that art may have been in pre-Buddhist times. It is doubtful if any country in the world, at the period in question, possessed a very much more perfect knowledge than the Buddhist excavators.

Professor Macdonell goes into great detail on the origin of the Chinese pagoda and of the Indo-Aryan temple. I am sorry to say I do not regard his remarks on these subjects as the most valuable portions of his paper. He says, for example, that Fergusson in his "History of Eastern Architecture," suggests that the Chinese pagoda is derived from the Stupa, but that he nowhere tries to prove the connection, though some of the illustrations in his own work supply part of the evidence. I am afraid I can hardly agree with that statement. In his "Rock-cut Temples" (p. 27), speaking of cave 19 at Ajanta, Fergusson observes, "The upper part of the daghopa is also seen with its three umbrellas, but these have departed still further from their wooden prototypes and are fast approaching those forms which give rise to the three, six, and nine-storied towers of the Jains and which are still built at the present day in China. The connection between the porcelain tower at Nankin and a hemispherical dome surmounted by a wooden umbrella is certainly not at first sight apparent; but there are few things more clear than that the one is the direct lineal descendant of the other and every step of the change can be pointed out."

It is necessary to read the whole of Fergusson's works before one can be quite dogmatic in affirming that he has not observed this and that aspect of Indian architecture. Few subjects of importance escaped his observation.

TWELFTH ORDINARY MEETING.

Wednesday, March 3rd, 1909; Sir EDWIN DURNING-LAWRENCE, Bart., LL.B., in the chair.

The following candidates were proposed for election as members of the Society:—

Barnes, Major Arthur Alison Stuart, 16, Hankow-road, Shonghai, China.

Schevabachr, Hermann, Ph.D., 48, George-street Portman-square, W.

Strangways, Guy Ernest Alan, 56, Holland-road, W.
Wong Ah Fook, 31, Kling-street, Singapore, Straits Settlement.

The following candidates were balloted for and duly elected members of the Society :—

Burns, Cecil Laurence, 56, Glebe-place, Chelsea, S.W.
O'Farrell, Thomas A., J.P., 30, Lansdowne-road, Dublin.
Pulford, William James, Maldon, Essex.
Ramos, Professor Dr. Mario de Andrade, S. Clemente 295, Rio de Janeiro, Brazil, S. America.
Seager, James Albert, Assoc.M.Inst.C.E., Emerson-chambers, Newcastle-on-Tyne.
Shipley, John Franklin, 63, Shorrolds-road, Walham-green, S.W.
Solomon, Hon. Sir Richard, K.C.B., K.C.M.G., K.C.V.O., K.C., M.A., 42, Hyde-park-square, W.
Tickle, Arthur Henry, 11, Mount-street, W.

The paper read was—

DEW-PONDS.

By George Hubbard, F.S.A., F.R.I.B.A.

Before attempting to discuss the conditions which must be present where a dew-pond is in active operation, it is perhaps necessary to explain shortly what is meant by a dew-pond.

The essential difference between a dew-pond and an ordinary pond lies in the fact that the ordinary pond obtains its water supply from springs or surface water drainage; but the dew-pond, owing to its special form of construction and the nature of the materials used in it, will condense the moisture from the air. As the air is present all over the surface of the earth, the question which presents itself to the practical mind is, whether dew-ponds could with advantage be introduced into waterless lands? To predict the answer to this question it is necessary to know not only the temperature of atmosphere as measured by the dry and wet bulb thermometers, but also the radiating power of the surface of the pond. It is particularly in relation to these points that I propose this evening to direct attention.

As the moisture has to be condensed from the air, it is first necessary to investigate the composition of the air we breathe.

Atmospheric air is a mixture of nitrogen, oxygen, carbonic acid gas, ammonia, argon, neon, helium, and aqueous vapour. All these gases are present in constant proportions except aqueous vapour, which is subject to very large variations.

This gas, or aqueous vapour, is always being given off from any surface of water or even from ice until the atmosphere becomes saturated with it. The point of saturation, or the dew-point, represents that state of the atmosphere when it cannot contain any additional moisture or aqueous vapour, at a given temperature.

The dew-point varies with the temperature. The higher the temperature of the air the more aqueous vapour it is capable of containing. The state of saturation is made known when the dry and wet thermometers record the same temperature.

The dry bulb thermometer gives the temperature of the surrounding air, but a wet bulb thermometer gives the temperature of evaporation from its surface. Around the bulb of the wet bulb thermometer is attached a fine piece of muslin, which is always kept moist, the consequence being that the wet bulb thermometer is chilled in direct proportion to the rapidity of evaporation from its surface; that is, in direct proportion to the dryness of the surrounding air. Thus, from the data given by the simultaneous reading of these two thermometers, it can easily be calculated by Glaisher's "Hygrometrical Tables" what the temperature of the dew-point would be.

It is obvious that if the temperature of saturated atmosphere is lowered, then the moisture that it cannot contain at such lower temperature must be deposited. This deposition of aqueous vapour sometimes forms dew, or it may fall as rain, or remain suspended in the air as a mist. If the temperature of the atmosphere is again raised without any chance of its coming in contact with any form of moisture, then the atmosphere is comparatively dry and evaporation from any moist surface is rapid. In fact, as the temperature of the atmosphere rises it absorbs moisture whenever it comes in contact with it, and as it falls below the dew-point it deposits its excess of moisture.

The process of evaporation takes up pure aqueous vapour from even the most fœtid pools, and it is again distributed on the surface of the earth in the form of pure water when the temperature falls below the dew-point. If it were not for this action and reaction, life, as we know it, would be impossible on the earth.

Passing from these elementary remarks, we must now consider by what process the temperature of the atmosphere can be chilled below

the dew-point, so that its superabundance of aqueous vapour shall be deposited at the lower temperature upon a desired surface. Before, however, directly dealing with this point, it must be realised that the portion of the earth receiving the sun's rays during the day is absorbing a certain amount of heat. Generally speaking, one-half of the heat of the sun received by the illuminated atmosphere is absorbed by the air, leaving the other half to reach the surface of the ground, provided that there are no intercepting clouds.

This process of absorption of the heat of the sun during the day is reversed during the night. For our present purpose it may be assumed that the heat received either by the atmosphere, or by any portion of the surface of the earth, during the day, is radiated, during the night, into space. Thus the atmosphere which is warmed, during the day, is capable of containing a greater percentage of aqueous vapour than it can retain, if it is chilled below the dew-point, during the night.

When the temperature falls during the night below the dew-point, the excess of aqueous vapour, in the form of dew, is deposited. If, however, the sky during the night is overcast with clouds, the heat acquired by the atmosphere, during the day, is not so readily radiated; and, moreover, the heat acquired by the earth, during the day, is given off into the layer of air below the clouds, and the tendency is for the temperature of the atmosphere to be maintained. Under these conditions, the atmosphere will continue to contain the aqueous vapour, and little or no dew will be deposited.

It is on the clear starlight nights that the most copious depositions of dew take place.

The atmosphere may also be warmed or chilled by purely mechanical processes. Thus, if a lump of ice is placed in a glass of water the outside of the glass becomes chilled, and the moisture-laden air, coming in contact with the chilled surface of the glass, in its turn decreases in temperature. As soon as it falls below the dew-point the outside surface of the glass, especially if it has a rough and not a polished surface, becomes coated with beads of water. If now the glass of water containing the ice be placed on a plate, the dew will soon be seen running down the surface of the glass and forming a dew-pond in the plate.

From this example it will be seen that, provided a chilled surface can be produced which will lower the surrounding temperature of the atmosphere below the dew-point, the aqueous vapour will be condensed on the chilled surface.

If it were possible to isolate a small portion of the earth's surface from its surroundings, it would readily radiate its acquired heat of the day, and its relative temperature to the earth would be lower.

As a concrete example of this, the well-known method adopted in India for procuring ice is worth recording. For an account of this I quote from Scott's "Meteorology," in the "International Scientific Series":—

"A very practical use of nocturnal radiation has been made from time immemorial in India in the preparation of ice, and on such a scale that about ten tons of ice can be procured in a single night, from twenty beds of the dimensions about to be given, when the temperature of the air is 15° or 20° Fahr. above the freezing point. The locality referred to is in the immediate neighbourhood of Calcutta. A rectangular piece of ground is marked out, lying east and west, and measuring 120 by 20 feet. This is excavated to a depth of two feet and filled with rice straw, rather loosely laid to within six inches of the surface of the ground.

"The ice is formed in shallow dishes of porous earthenware, and the amount of water placed in each is regulated by the amount of ice expected. No ice is formed if the wind is sufficiently strong to be called a breeze, for the air is not left long enough at rest, above the bed, for the temperature to fall sufficiently by the action of radiation."

To obtain this result I should imagine that it is essential that it should be a cloudless night, and the air comparatively still. Mr. Scott points out that this freezing action ceases with southern or easterly airs, which contain more moisture than the North-North-West airs. It is when the wind is in the North-North-West that the freezing action is most active, and it is largely owing to the chilling effect of evaporation in the dryer airs that the freezing temperature is reached.

From this example it will be readily seen that the straw lining is a non-conductor of heat, and thus prevents the pans of water from absorbing the heat of the surrounding earth.

A portion of the heat that the water and the pans contained in the first instance having been radiated during the night, the temperature of the water has been caused to fall to the freezing point.

It is well to bear in mind this striking illustration of the low temperature which can be attained by a body of water protected by a non-conductor of heat from contact with the surrounding earth. The chilling effect is of

course accelerated by the process of evaporation. In miniature, we have here almost the same conditions which operate in a properly constructed dew-pond.

Another example, which will be more familiar to everybody, may be seen on the railways where the sleepers are entirely covered by gravel. On a frosty morning it may be often observed that the hoar frost covers the gravel lying immediately above the wooden sleepers, whereas the gravel lying between the sleepers shows no signs of hoar frost. In this case the wooden sleepers act as a non-conductor, and the gravel lying above them having radiated into space, a certain amount of the acquired heat of the day becomes chilled, and the dew which is deposited upon this protected gravel becomes frozen, and appears as hoar frost.

Illustrations might be quoted without number, but my object, in referring to these instances, is to emphasise the fact that, by the application of simple automatic conditions, definite results may be obtained which may some day prove to be of great importance to humanity.

In certain countries where there are neither rivers nor springs, and where the rain seldom or never falls, the conditions appear to render such localities unsuitable for man and beast. Yet by the application of scientific principles, a constant water supply will be obtained if it is possible to lower the temperature of the air, in contact with the chilled surface of a dew-pond, below the dew-point.

In numerous dew-ponds in this country the dew-point is reached without difficulty. But not till my brother, Dr. Hubbard, first suggested the physical action that was in progress, was any scientific explanation advanced as to why these ponds remained charged with water through the longest summer and in the absence of all springs or surface drainage. Furthermore, it was he who first showed that these ponds furnished the principal water supply to those prehistoric races who lived on the hill tops on the South Downs thousands of years ago. On the higher part of the Downs, and sometimes on the very summit of the Downs, such ponds may be seen. From time immemorial a certain definite form of construction seems to have been adopted. For a description of this I quote from "Neolithic Dew-ponds and Cattleways," the joint work of my brother and myself:—

"Operations are commenced by hollowing out the earth for a space far in excess of the apparent requirements of the proposed pond. The whole of the hollow is then thickly covered with a coating of dry straw. The straw in its turn is covered by a layer of well-chosen, finely-puddled clay, and the upper surface of the clay is then closely strewn with stones. Care must be taken that the margin of the straw is effectively protected by clay.

"The pond will gradually become filled with water, the more rapidly the larger it is, even though no rain may fall. If such a structure is situated on the summit of a down, during the warmth of a summer day the earth will have stored a considerable amount of heat, while the pond, protected from the heat by the non-conductivity of the straw, is at the same time chilled by the process of evaporation from the puddled clay. The consequence is that during the night the moisture of the comparatively warm air is condensed on the surface of the cold clay. Owing to the chilling effect of evaporation from this thermally isolated surface, the condensation during the night is in excess of the evaporation during the day, and the pond becomes, night by night, gradually filled. The dew-pond will cease to attract the dew if the layer of straw should get wet, as it then becomes of the same temperature as the surrounding earth, and ceases to act as a non-conductor of heat."

In a work recently published by Mr. Hadrian Allcroft, entitled "Earthworks of England," a lengthy chapter is devoted to Dew-ponds. Though the thermo-dynamics of the subject are not, I fear, well understood by Mr. Allcroft, still in a foot-note he gives a few interesting statistics, which he states have been found by actual experiments, as to the accumulation of water in a dew-pond.

"A dew-pond may rise," he says, "as much as 2 inches in a single foggy night in January, and in five nights rise fully 8 inches.

"In the early summer the same pond collected 3½ inches of water upon five nights of heavy dew."

The heaviest rain-fall in these islands would never probably give anything approaching this result within the same time, and the full effect of this may perhaps be better appreciated, when it is realised that an inch fall of rain represents slightly over 100 tons of water to the acre.

Those ponds which are situated at the highest elevation are certainly more successful than those in the valleys. The reason for this appears to lie in the fact that the invisible aqueous vapour is carried upward in the air currents. As the air rises into higher altitudes it expands, and this mechanical process of expansion lessens the temperature. As the temperature diminishes there is rapid condensation, and the condensation is greatest on the hill tops which rise above the warm air of the valleys, and more especially does this

condensation take place on the surface of the dew-ponds which have been artificially prepared. The hill tops which rise into the clear upper atmosphere radiate easily and act as condensers. All must have observed how the clouds hang around near the hill tops when the rest of the atmosphere seems clear. It is only when the invisible aqueous vapour condenses that it becomes apparent.

Dew-ponds appear to be only successful when constructed on a chalk bottom. Some people have therefore considered that the chalk must have some mysterious influence upon the result. This mysterious influence is, I fancy, only due to the fact that chalk is a sterile soil, and it is owing to the absence of worms that the layer of straw can remain dry.

A dew-pond on any other soil, except chalk, would be certain to fail if constructed exactly on the old methods, and it is for this reason, so far as I know, that dew-ponds are only found on a chalk formation.

In the absence of a chalk formation, it would be necessary to lay a foundation bed of cement-concrete, or asphalte, so that the non-conducting material should be protected against the destructive action of worms or other animals boring in the earth.

A thick layer of straw is a very good non-conductor, and its efficiency lies in the fact that the cellular formation of the straw contains still air, *i.e.*, not in motion. The rays of heat which are able to penetrate the straw structure are baffled by the still air, whereas those rays which can with comparative ease penetrate the still air are in their turn baffled by the structure of the straw. By the almost innumerable number of straw structures, with the still air in the cells, the heat rays fail to pass through the entire mass. Thus a good non-conductor of heat should be a material composed of substances of very different densities.

Experiments which were made by my brother and myself resulted in striking effects where we used mica as the non-conductor. We made wooden trays, two feet square, and painted them various colours. We also prepared square slabs, constructed from waste mica, two feet square and two inches thick. When we placed any one of our trays upon such a slab of mica, on the same night and side by side other trays, not on mica slabs, the result was that we generally obtained during the night just about twice as much water in the tray placed on the mica slab as we obtained upon the other trays. These experiments were carried out upon a gravel path where no sign of condensation appeared. The wood with which the trays were constructed is in itself a good non-conductor of heat, and it is partly owing to this fact that the trays placed directly on the gravel gained some moisture. A lawn at the side of the gravel path was wet with dew. The obvious reason of this is that the thin blades of grass, being only connected at their base with the earth, are able to radiate their heat easily, and, as they become chilled below the dew-point of the atmosphere, the dew is deposited upon each blade. Those trays painted green or those painted white obtained the most moisture, whereas those painted black invariably obtained the least.

The presence of chlorophyll in all vegetation, which gives it its green colour, may have some bearing on this point. The true parasitical plants, which rely upon obtaining their moisture from the trees upon which they grow, are rarely if ever green.

From this garden observation of the dew being on the grass, and not on the gravel path, it seems possible that an explanation may be found as to why certain lands are rainless. The wind passing over the ocean must absorb a considerable amount of moisture, provided it is not already saturated, and yet that moisture will pass over islands and whole districts without any rain falling upon them. Such lands are always barren rocky or sandy wastes. On such desert land there would be very little dew deposited, for the surface of the land becomes baked during the heat of the day, and the process of cooling during the night is too gradual to allow it to become sufficiently cool to chill the atmosphere below the dew-point. The consequence is that the land remains dry and parched, and yet the rough grass, that may perhaps grow in some places, becomes drenched with dew during the night; but the air, warmed by the sun's rays of the day, quickly absorbs the dew, and the earth remains parched. What the air gives up at night, it acquires again during the day.

Unless those conditions can be brought about by artificial means which will result in chilling the air on such a large scale as actually to change the climate, there is no chance of converting the desert wastes of the earth into fertile land. But this result will ultimately be attained in certain localities by the adoption of some form of dew-pond, or condensing surface, I have no doubt.

Take, for instance, the islands known as the Desertas, lying only twelve miles away from the island of Madeira. Madeira, as is well

known, is a most fertile island; the luxuriance of its vegetation strikes all who visit it; but the Desertas, of exactly the same geological formation, have neither springs nor rivers, and the rain is said never to fall. The islands are uninhabitable except by a few fishermen, who succeed in obtaining water by hanging out fleeces, from which in the morning they wring out the water gathered in the night. Here man, in his necessity, has applied a simple law of Nature. He has compelled the air to give up that which it would otherwise have retained.

These rocky islands (the Desertas), only partly covered by shrubby grass, are admirably adapted for the construction of dew-ponds; the moisture-laden atmosphere could most readily be induced to deposit its moisture on to properly-prepared surfaces. The water, however, that is thus deposited during the night should be run off into tanks so as to avoid the loss by evaporation during the day. The water obtained should, in the first instance, be used for rearing trees. The marked effect that trees have upon the climate is not generally appreciated, nor is it generally known how admirably they are adapted for extracting the moisture out of the air.

In any scheme for procuring water in waterless lands, trees must eventually play an important part, if not the most important part, and, therefore, at the risk of apparently departing from the question of dew-ponds, I am anxious to show the importance of arboriculture. Wood, as I have said, is a good non-conductor of heat, but the bark of a tree is a better non-conductor. The trunk of a tree is as slight as it can be with safety, having regard to the wind pressure on the spreading branches and the foliage. This being so, the whole superstructure of the tree is disconnected as far as possible from the earth, and the non-conducting property of the bark of the trunk further cuts off the heat rays from penetrating the wood. The trunk, branches, twigs, and the stalks to the leaves are each in turn as slight as possible, and the leaves themselves are as thin as may be. The leaves are, in fact, to a remarkable extent disconnected with the earth, and, owing to their great superficial area, as compared to their mass, they very quickly radiate into space any heat that they may have acquired during the day. Thus, shortly after sunset, these wafers gently flapping in the air having radiated their heat, chill the air as it passes over their surface. The chilling of the air induces the condensation upon them. If, now, the form of a leaf hanging down from its slender stalk is borne in mind, it will at once be realised how the water will drop off from its pointed end and fall on to leaves at a lower level, but which have a wider spread. This action is continued until the water drops to the ground around the margin of the tree's circumference. As a general rule, the roots extend underground just about as far as the branches do above ground. On the still and cloudless nights this dew which has been deposited upon the leaves may often be heard dripping to the ground, watering, in fact, the extremities of the roots, though not a drop of rain has fallen, and it is only at the extremities of the roots that the tree is capable of taking up the moisture for its nourishment. Nature has in the evolution of the tree most marvellously and perfectly fashioned it in all its parts, so that the maximum of moisture may be quickly extracted from the air after sunset.

Though there is the keenest competition between tree and tree in the forest, they do in fact co-operate together to bring about such a general chilling of the air as will result in inducing rain to fall.

Think of the slight chilling effect upon the atmosphere by one leaf, and this effect must be multiplied by thousands for one tree, and this again by every tree in the forest.

In the *Daily Graphic* of January 22nd, in the article on the "Effect on the Afforestation Scheme," this statement appears:—

"The Washington Elm of Cambridge—a tree of no extraordinary size—was estimated to produce a crop of seven millions of leaves, exposing a surface of about five acres of foliage."

A cold stream of air emerging out of a forest of such trees, would come in contact with the surrounding warmer air which has not been subject to this chilling process. The contact of the atmospheres at different temperatures would probably result in such a copious condensation that we should appreciate its effect in a downpour of rain.

From the Official Year Book of the Commonwealth of Australia, speaking of the direct influence of forests on rainfalls, Dr. Hann is quoted as saying:—

"In the Cordilleras, clouds with rain falling from them can be seen hanging over forests, while over contiguous lands covered with shrubs or used for agriculture, the sky is blue and the sun is shining."

To return again to the Desertas, or the desert islands, as the name implies. If young

trees were here planted and the extremities of their roots were watered with the water from the dew-ponds that might be constructed, the trees should flourish. Their foliage, in the course of a few years, would probably induce rain to fall, and after this, these desert islands would become as beautiful and perhaps as prosperous, as their adjacent island, Madeira.

Since my brother and I published our small book on Dew-ponds it has come to our notice that the Government has adopted the principle we therein enunciated. At Gibraltar a large portion of the rock has been covered with corrugated iron on a wooden backing. On this surface the warm moisture-laden wind becomes chilled, and the dew is deposited, and if I am rightly informed Gibraltar has now a supply of pure water.

In this case success was assured from the commencement, and my brother and I are equally certain that a successful result will follow in other places, such as the Desertas, where the conditions are all so eminently favourable, and so obviously comply with the conditions I enunciated at the commencement of my paper, that is, that the radiating surface must be sufficiently energetic to induce the temperature of the atmosphere to fall below the dew-point.

But many persons have asked whether a successful result could be attained in the deserts of Egypt or the waterless districts in Australia and South Africa.

To determine this all important point it is necessary to examine the subject more closely, and to discover if possible by how many degrees a radiating substance will fall below its surrounding medium.

There appears to be a limit to which any substance will fall in temperature by radiation in relation to its surrounding medium. And when that limit has been reached the tendency is that it shall be maintained.

On this point M. Poullet has proved that in the month of April, when the temperature of the air was 38·48° Fahr., swansdown fell by radiation to 25·7° Fahr., the whole chilling therefore was 12·78° Fahr. In the month of June, when the temperature of the air was 63·95° Fahr., the temperature of the radiating swansdown was 50.972° Fahr.; the chilling of the swansdown by radiation here is 12·978° Fahr., almost precisely the same as that which occurred in April. On this point Tyndall says:—

"Thus, while the general temperature varies within wide limits, the difference of temperature between the radiating body and the surrounding air remains sensibly constant."

These facts enabled Melloni to make an important addition to the theory of dew. He found that a glass thermometer placed on the grass is never chilled more than 3·6° Fahr. below an adjacent thermometer with silvered bulbs which hardly radiates at all. These 3·6° Fahr. or thereabouts, mark the thermometric distance above referred to, which the grass tends to preserve between it and the surrounding air.

Yet if a thermometer is placed on the grass, and a second thermometer hung a few feet above the grass, the suspended thermometer may record 18° Fahr. or more above the reading of the thermometer on the grass. Melloni explains this as follows:—

"The grass blades first chill themselves by radiation, 3·6° Fahr. below the surrounding air; the air is then chilled by contact with the grass, and forms around it a cold aërial bath. But the tendency of the grass is to keep the above constant difference between its own temperature and that of the surrounding medium. It therefore sinks lower, the air sinks in its turn, being still further chilled by contact with the grass; the grass, however, seeks to re-establish the former difference; it is again followed by the air, and thus, by a series of actions and reactions, the entire stratum of air in contact with the grass becomes lowered to a temperature far below that which corresponds to the radiative energy of the grass."

Thus it is seen that the radiative energy of swansdown is 12·6° Fahr., and that of grass is 3·6° Fahr., but in either case the thermometric distance may be very considerably increased on a still night, when the air is allowed to remain in contact with the heat-radiating body. Swansdown is the better radiator of heat on account of its comparative enormous surface as compared to its mass, thus affording every part an almost unhindered opportunity of quick radiation.

All substances doubtless have their thermometric distance; but with solid or compact substances, this distance would be more readily reached by isolating them from the earth, or by placing them on a non-conductor of heat, so that the loss of heat by radiation is not supplemented from the earth.

The more perfect the non-conductor of heat that is used, the more accurately and quickly the absolute thermometric distance will be approached. In all cases the mass of the material, on which the experiment is tried, must not be so great that it will not have time

to cool sufficiently to reach its thermometric distance between sunset and sunrise.

The thermometric distance of the surface of a dew-pond will be determined by the degree of efficiency of the non-conductor employed, and the neat-radiating power of the surface material of the pond. The result, however, may be reinforced by the chilling effect it will have upon the air, in contact with its surface on a still night, in a manner precisely similar to the low temperature that I have before quoted in the case of the thermometer situated on the grass, which fell 18° Fahr. below the temperature of the air a few feet above the grass, when the true thermometric distance of grass is only 3·6° Fahr.

From experiments I have lately been conducting I find, that if a thin sheet of iron, about 15 inches square, with a piece of asbestos sheeting on its under side, be suspended in the air during a fairly clear night, then the temperature of the surface of the iron falls 9° Fahr. below the temperature of the atmosphere at the same elevation. Its thermometric distance appears to be 9° Fahr. under the conditions above mentioned, whereas grass is 3·6° Fahr., but by the reinforcing agency of air remaining in contact with an expanse of grass, the temperature falls 18° Fahr. or more.

If anything like the same ratio could be attained on a large surface of thin iron with a non-conductor below it, as is attained in the case of grass, then a very low temperature indeed should be obtained on the iron surface. My small sheet of iron is of course too small for the air to remain in contact with it for an appreciable time, and so the maximum chilling effect upon the air is unknown.

Thin metal plates are good radiators of heat, that is to say, that they will quickly give off heat that they have acquired, and if the plates were superimposed on dry straw they would be protected from acquiring any radiated heat from the earth below the straw. The surface of the iron in such a structure, after sunset, would readily fall in temperature, and as soon as the temperature falls below the dew-point the aqueous vapour of the atmosphere will be deposited upon its surface.

If I now turn to the Annual Report of the Meteorological Department of the Transvaal for the year ending June, 1907, I find that at Modderfontein, in the Pretoria District, no rain fell in July and August, 1906, nor in June, 1907. The annual returns are made up to the end of June, which accounts for the difference of year date for this month. It may, however, be safely asserted that no rain falls in the Pretoria District during any of these three months of June, July, and August, and yet I find that at 6 a.m., the hour at which the temperatures are recorded, the dew-point is never as much as 10° Fahr. below the temperature of the air.

In this particular locality there can be no doubt that a water supply could be obtained, for the thermometric distance even of the iron plate will almost touch the dew-point, and the reinforcement which would be obtained by having a large area of iron would produce a temperature far below the dew-point.

Unfortunately the returns in the Official Year Book of the Commonwealth of Australia do not give just the information which would enable me to predict whether such a radiating surface would result in bringing about such a fall in temperature as to reach the dew-point.

I would suggest that readings should be taken just before sunrise, at elevated stations, facing the quarter from which come the rain-bearing winds. It should be remembered that all winds having a downward tendency are comparatively dry winds. They have lost their moisture in their ascent to the cold high regions from which they are descending. From the result of further experiments which might be carried out in this country, taken in conjunction with thermometer readings at suitable hours in any part of the world, it should be possible to predict, with a scientific certainty, the chances of extracting the moisture from the air.

If water is obtained, trees should be nursed into existence. The result may end by changing the climate over great tracts of land and so increasing the habitable area of the globe.

There is no need to dwell on the vital importance of obtaining water in waterless lands. The famines, which result in the death of thousands at a time in India, are due to the failure of the crops in a dry season, and the loss of millions of sheep which annually die in Australia is due to the lack of water.

That water will some day be produced, in small quantities, perhaps, at first, I have no doubt; but the result in the end may be, that, in other lands than ours, the words of Kipling may be sung:—

> "We have no water to delight
> Our broad and brookless vales,
> Only the dew-pond on the height,
> Unfed that never fails."

DISCUSSION.

The CHAIRMAN (Sir Edwin Durning-Lawrence), in opening the discussion, said that the reference in the paper to the inhabitants of the Desertas Island wringing fleeces to obtain water, reminded him of the familiar story of Gideon, who professed to ascertain the Divine will by the two experiments, in one of which the exposed fleece was moist and the ground dry, while in the other the fleece was dry and the ground wet. The reason for this he had never understood. The story of Gideon was at least 3,000 years old, and the dew-ponds, illustrations of which had been shown, were probably as much as five or ten thousand years old in their initiative. An important point to bear in mind was, had the people of the present time yet learned all they could from the past? Was it not possible to learn from the past how to get water in certain places, as the British Government had done at Gibraltar, by making a dew-pond there directly in consequence of the publication of the author's book?* It was quite possible, he should imagine, in the Desertas Islands, which were only 12 miles from Madeira, with the sea all round them, to make effective dew-ponds, although he should not expect to get water by evaporation in an African desert. The *Journal* of the Society containing the paper would be sent all over the world, and it was to be hoped that through the publication of the paper water might be brought to places where it did not at present exist.

Mr G. BLUNDELL said the author had stated that dew-ponds were constructed by an excavation being made, then a layer of straw was put in, and finally clay puddled over the straw. He desired to ask the author if he could give a case in this country where the straw was put in first, because it was his impression that it would be practically impossible to puddle clay over a thickness of six or eight inches of straw. The author had explained that the theory was based on the straw being at the bottom; in practice he (Mr. Blundell) knew that the straw was always placed over the clay. He knew a good many dew-ponds that had been made without straw, and there were a great many dew-ponds made on the Cotswold Hills upon the limestone, the neolithic formation. A large proportion of dew-ponds had been made in Wiltshire and Sussex on the chalk, but, as far as he was informed, the whole of them were made first with the puddled clay, the straw being put on the top of the clay to protect it from cracking from frost, or from the rubble that was put over injuring the clay.

MR. T. S. DYMOND (Board of Education) enquired whether the author had any particulars of the amount of atmospheric moisture over the chalk or limestone as compared with that over other geological formations. He was particularly interested in Essex, which did not possess the advantage of springs from the chalk. The soil was very heavy London clay in many parts, and the only source of water in the district was the water saved in ponds on the top of the clay. In many dry seasons water altogether failed, and the question occurred to him therefore why no dew-ponds were to be found in Essex. He thought perhaps the cracking of the clay might prevent a dew-pond constructed as the author had described from holding water; but it also occurred to him, after what had been stated about the use of iron plates, that it would be quite possible to construct dew-ponds with iron plates over the clay, without any risk of their being spoiled by the cracks which developed in the clay in dry summers. He thought the subject largely depended on the question as to whether there was sufficient moisture in the atmosphere, and whether on the chalk and limestone the proportion of atmospheric moisture was not very much greater than it was on a clay formation. There was no chalk under the clay in Essex, until a depth of 600 feet was reached.

Mr. W. P. D. STEBBING said that the shallow depressions on the north downs of Surrey, where there was a thick formation of clay and redeposited gravel on the top of the chalk, were very often full of water, and it was very seldom that the depressions dried up, even in the hottest summer. On the commons there was very often a great deal of heather and surrounding vegetation, and there were a good many water plants in the water. He desired to ask the author whether, in his opinion, the surrounding vegetation fed the shallow depressions at night more than they would evaporate in the day. With regard to the corrugated iron used at Gibraltar, he remembered that a friend of his, some years ago, who wanted to make a large pond in his garden, collected the water for the pond by erecting a range of corrugated iron behind a hedge. But instead of placing it on a non-conducting substance, it was just supported on iron rods and on wooden quartering, without any backing at all. A good deal of water was obtained, but he believed most of it came from the rainfall, because his friend had no idea of arresting the dew, and so getting a certain amount of water from the corrugated iron, during every night, winter and summer.

MR. JOHN SLATER said he wished to refer to one point which was rather of archæological than scientific interest. The author had alluded in his paper to a number of unmistakeable dew-ponds which he said he was convinced had existed from pre-historic times. If that was the case, their effectiveness must have lasted a very long time indeed. He should be glad to know if Mr. Hubbard had any information as to the depth of the existing dew-ponds, and whether any excavations had been made to ascertain what the substratum under the dew-ponds was.

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* "Neolithic Dew-ponds and Cattle-ways." By Arthur John Hubbard, M.D., and George Hubbard, F.S.A., F.R.I.B.A. London: Longmans, Green, and Co.

Mr. A. GORHAM inquired whether there was any reason why dew-ponds should not be lined with cement, which he thought would prevent the water leaking away. He had noticed in many cases that ponds were lined with cement; why should not such ponds collect the dew just as well as ponds made with ordinary puddle clay?

Mr. T. S. DYMOND said the author had not suggested that the fact of the dew-ponds being on chalk had anything to do with the formation of dew; but he (Mr. Dymond) could not help thinking that chalk and limestone, owing to their porosity, got much colder by evaporation than certain other geological strata. He believed it would be found that all the ice caverns of the world, certainly those in Hungary, were in limestone. By the evaporation of water from the limestone great cold was produced; was it not possible that the chalk being porous, and there also being a great deal of evaporation from it, the cooling effect of the evaporation on the chalk had something to do with the existence of dew-ponds in the chalk?

The CHAIRMAN (interposing) said the author did not suggest that in the dew-ponds he had shown the water flowed from the surface into them. Some of them were so high that they could not receive any drainage.

Mr. DYMOND said he was glad the author had made that clear, because it had been asserted time after time that the ponds were filled by drainage, and a statement was made to that effect in *Nature* not very long ago.

Mr. A. W. OKE pointed out that there was absolutely no evidence in the paper as to the extreme age of the dew-ponds, and thought that some reference should be given, either to the author's own book or other sources as to information on the point, because he was rather sceptical of dew-ponds.

Mr. W. N. BLAIR said he had heard on good authority that every dew-pond on the Surrey hills was made in the memory of living men, and he was, therefore, very much surprised to hear that some were as old as the author had stated. The statement had been made to him that it was impossible for any formation to hold water for more than a century, as the bottom was always sure to leak. With regard to the question of green leaves attracting moisture, Mr. Seaton Thomson, the naturalist of Canada, had proved that, since the lumbermen had cut down the trees, some of the Canadian rivers which previously flowed through the forests, were dry all through the year, whereas they used to have a constant flow of water. He should like to know whether it was necessary that straw should be used in the formation of dew-ponds. He had seen some ponds on the hills in the New Forest district, Hampshire, which apparently had no drainage running through them, which had a natural gravel bottom, but he took it they were natural dew-ponds. They apparently had an ordinary gravel bottom with probably clay underneath. They were all on the high downs, although the ground was not very high.

Mr. LEON GASTER inquired what amount of water could be relied upon from a certain area if a dew-pond was constructed. A small amount of water was better than nothing, but it might not be enough. He endorsed the statement Mr. Blair had made with regard to afforestation. In those countries where the trees had been cut down without any regulation the flow of water in the rivers had largely decreased. Afforestation had another advantage in that it considerably purified the air, all the CO_2 which people breathed out being taken up by the trees during the day.

Dr. F. S. TOOGOOD, in dealing with the question of the age of dew-ponds, said he felt sure the author was acquainted with Maiden Castle, near Dorchester, where there was evidence that the dew-pond which existed in the enormous ring there must be of an age dating back at any rate to the time when the castle was made, because otherwise he failed to see any reason why there should be a pond up there at all, there being an efficient stream of water running at the bottom. That pointed to the fact that the pond was constructed at a time when the camp was used as a refuge for the inhabitants, who doubtless took their cattle up there, and would necssarily want some means for giving them water if they were beleaguered and unable to get to the stream which flowed at the bottom.

Mr. W. R. STRATTON asked whether instances were not known where natural ponds were not also in the nature of dew-ponds. In the Colesburg district of Cape Colony he noticed some eighteen or twenty years ago certain ponds on the farms where the water in the dry season was higher in the morning than in the evening. There was no stream flowing into or out of the ponds, and they were fairly high up; in fact, there were no springs anywhere in the district for miles, and yet the ponds were always full of water in the driest weather. It was a mystery to him at the time as to how the water got into the ponds.

Mr. HUBBARD, in reply to Mr. Blundell, said the method of making dew-ponds described in the paper was the customary way of making them, and he had in his possession at home an extract from a lease dated 1700 and odd in which minute particulars were given as to how the dew-pond was to be formed. It had to have four feet of straw, and then two feet of clay on the top of the straw.

Mr. BLUNDELL, interposing, said that all the dew-ponds made at present on the Duke of Norfolk's estate in Sussex, and Lord Wantage's estate in Berkshire were, to his certain knowledge, made with the puddle clay first, the straw being put on afterwards.

Mr. HUBBARD stated that on the Southdowns in Sussex the exact opposite was the custom. Mr. Dymond had referred to the aqueous vapour over various geological formations, but he was unable to give any definite answer on that point, as he had no information on the subject of radiation from various geological formations. Mr. Dymond also thought that the chalk or limestone became colder than other materials, and that it might have been the cause of extracting the aqueous vapour out of the atmosphere. He hardly imagined that that would be so, because either the chalk or the limestone would not of itself make a very water-tight bed to a pond; it would have to be covered with some impervious material such as clay. If reliance were placed upon the chilling effect of chalk and limestone, it was not likely to be realised if it were covered with clay. It seemed to him there would be a greater deposition of dew all round the pond and not in the pond itself, so that the object aimed at would be defeated. He did not know why dew-ponds should not be lined with cement, and did not think that affected the question at all. Most of the dew-ponds he knew were lined with cement; but, as a rule, when coating them with cement, the repairer, in trying to make gulleys to conduct the surface drainage into the ponds, had cut through the side, and through the clay, and allowed the surface drainage water to penetrate the non-conducting straw underneath the clay. That effect of the straw getting wet was that it at once became of the same temperature as the earth, and absolutely failed to act as a non-conductor of heat. Faggots would do very well indeed instead of straw, especially if the outside margin of the pond were sealed so that no air was blowing through the faggots. They would then be building in still air, which, next to a true vacuum, was perhaps the best non-conductor that could be obtained.

The CHAIRMAN, interposing, said he thought faggots would rot a good deal more quickly than straw, which was an extremely durable substance. He had seen a sort of straw thatch used for plastering under lathes which was 400 or 500 years old.

Mr. HUBBARD, continuing, said he very much doubted whether straw would ever decay if it were hermetically sealed. Mr. Slater had referred to the age of dew-ponds. He (the author) had especially not touched on the question of dew-ponds from their archæological point of view, and had endeavoured to confine his remarks, as much as possible, to the scientific aspect of the question. That subject was fully dealt with in his book. With regard to the suggestion that all the ponds on the Surrey hills were said to have been made within the memory of living man, he had questioned a great many shepherds and old men on the subject, who had over and over again told him that the ponds had always been there as long as they had known the hills. It was a very odd thing that, if a man was called in to repair a pond, he ultimately came to think he made it. The evidence of the roads leading down from the embankments in more than one instance, such as was shown in the photographs, was very strong evidence indeed of their great antiquity—an antiquity which could be measured by thousands of years. The reference made to the dew-pond in Maiden Castle, which he knew well, was another proof of it. With regard to the amount of water which could be obtained in a dew-pond, it entirely depended upon the conditions under which the pond had been made, where it was situated, and also on the climatic conditions. If the whole subject were an exact science, it might be possible to give definite information on the point, but it must be borne in mind that the science of the subject was in its infancy. Even in the "Encyclopædia Brittanica" the word "dew-pond" did not appear. The remarks made with regard to the ponds at Colesberg in Cape Colony were extremely valuable. There could be no doubt that the ponds which were rising during the night were acting as dew-ponds; and the information from such a locality was extremely interesting. One of the directors of the Chartered Company of South Africa had told him of certain depressions in the Karoo district, which appeared to him to be very similar in appearance to the depressions which were often found upon the South downs in England, and which were, he thought, probably ancient dew-ponds. It would be very interesting to ascertain ultimately that those were dew-ponds in that waterless district.

Mr. LEON GASTER enquired whether the author, with the knowledge and experience at present available, could predict the amount of water likely to be obtained from a dew-pond, provided that certain necessary *data* were furnished. This question had a paactical and direct bearing on the re-habitation of some of the deserted parts of Palestine which suffer from drought.

Mr. HUBBARD replied that if he had the temperatures, as measured by the dry and wet bulb thermometers, he would know by how much it would be necessary to deduce the temperature of the air lying immediately above the condensing surface in order to get at the dew-point. As, however, the temperatures were constantly varying, what might hold good for one night would not hold good for the other 364 in the year; but he could probably tell approximately the mean amount of water which would be obtained if he knew the mean temperatures. The Chairman's remarks with reference to Gideon's fleece were amongst the most in-

teresting that had been made. As he understood it, the first miracle by which Gideon asked God to direct him was, that the dew should come on the fleece only, and that it should be dry upon all the land; and the second miracle was that it should be dry upon the fleece and the dew be upon all the ground. He spoke in no irreverent spirit, but he could not deny that those miracles appeared to him o be susceptible of a scientific explanation. Taking the conditions as they were given in "Judges," the threshing floor must have been a bare piece of ground, and a fleece, as was well known, was an excellent non-conductor of heat, which would very quickly radiate its heat owing to its great superficial area as compared with its mass; in fact, every part of it would have an unhindered opportunity of radiating its heat. The superficial area of a hair was very great as compared with the total bulk of the hair. Assuming, for argument's sake, that the day preceding the night on which the first experiment was to be tried was a very hot one, and assuming also that Gideon threw his fleece down early in the morning, what would be the effect? The baking sun would heat all the earth, but the patch of land underlying the fleece would remain comparatively cold, as the heat rays would not easily or readily penetrate the non-conducting material of the fleece. During the night the ground apparently did not decrease sufficiently in temperature to touch the dew-point, and in consequence the dew was not deposited upon it, but the fleece lying on a thermally isolated patch of ground would quickly radiate its acquired heat of the day; and as the decreasing temperature was below the dew-point, the dew would in consequence be deposited upon it. Therefore, so far as the first portion of the miracle was concerned, it was certainly capable of a perfectly easy and reasonable explanation. In the second portion of the experiment, the dew was on the land and the fleece remained dry, exactly the opposite of what took place in the first instance. The day preceding the second experiment could not have been so bakingly hot as on the former occasion, for the temperature of the ground fell below the dew-point, and the dew was deposited upon its surface. At the time the second experiment was done, Gideon must have thrown his fleece down during the afternoon when the ground was still hot. The fleece would tend to conserve the heat in the ground, and during the night the fleece would be lying on a warm patch of ground, the tendency of which would be that the temperature of the fleece would be maintained, and the dew in consequence would not be deposited upon its surface. That he thought was the explanation.

The CHAIRMAN, in proposing a hearty vote of thanks to Mr. Hubbard for his extremely valuable and interesting paper, said that during the last 120 years, many, if not most of the inventions that had tended to change the face of the earth had been first introduced in the theatre of the Royal Society of Arts. He did not say that Mr. Hubbard's invention was sure to be one of them, but he felt it possessed very great possibilities. The facts which had been given with regard to Colesberg, in South Africa, proved the possibility of doing these artificially to considerable extent what Nature had already partially done. The *Journal* of the Society, containing the paper, would be circulated all over the world, and he had no doubt that many men who read it in outlying parts of the earth would, first of all, put out a fleece, then dig a small hole, and see if any water came in it; so that the paper, which had been given to only a small audience on a wintry night, might be the means, in the not very distant future, of turning Desertas, wherever those Desertas might be, into cultivated lands, if they were within range of a water-laden wind coming from over the seas.

The vote of thanks having been carried, the meeting terminated.

THE PATENTS ACT.

The Board of Directors of the Manchester Chamber of Commerce have issued a circular on the Patents and Designs Act, 1907, from which the following extracts are taken:—

"The great advantages to this country attendant upon the passing of the Patents and Designs Act, 1907, have not, so far, been sufficiently appreciated by manufacturers and merchants in the United Kingdom. The Chemical Section of the Manchester Chamber of Commerce, who were—at the instance of Mr. Levinstein—in a large measure responsible for the new Act, think it is desirable to emphasise some important features of that Act, and to bring home to English business men the benefits which, through them, the country at large, may derive from giving close attention to the more important existing patents and to new patent applications. Before enumerating these important features, it may be pointed out that it is not intended to act in any vindictive spirit towards foreign owners of patents. . . . Now however, a foreign patentee must either work his patent on an adequate scale within the United Kingdom or grant licenses on reasonable terms, if he wishes to avoid the risk of having his patent revoked. . . .

"Several actions for revocation of existing patents under the new Act have already been commenced. There can be little donbt that the number would increase considerably, especially if the details of the decisions already given by the Comptroller-General under the new Act were studied. A few salient features of two judgments recently given for the revocation of patents are appended.

"One invention, relating to the manufacture

imitation stone, was being worked on a commercial scale in Germany, France, and Belgium, under licenses from the patentee, but not in the United Kingdom, because the patentee urged that all the wants of this country could be supplied from Belgium, and that the cost of material and labour here were too dear. The patentee also urged that he had received no application to work his patent when he advertised his willingness to grant licenses, or to enter into working arrangements with English manufacturers.

"The Comptroller-General, in his decision, said the interests of the public must be considered as well as those of the patentee. The latter had taken advantage of his monopoly of sale, but not of his monopoly of manufacture. The Comptroller-General said he failed to see any valid reason for not manufacturing commercially in this country. The materials used were no dearer here than abroad, and as readily obtainable. If the question of wages being higher here than abroad stood in the way, why should other industries be carried on successfully in this country? The advertisements of the patentee, offering his process, were vague, and mentioned no terms beyond the statement that the terms would be reasonable.

"The principal object of several sections of the Act was to stop the practice of taking patents to prevent their being worked here. If it were true that the patentee could not afford to work the processes in this country, and that if he did he would have to raise the price of the patented article to the consumer, it would be no kindness either to the patentee or to the public to delay revocation. Revocation would probably induce somebody to start manufacture as there would be no royalties to pay; also other countries besides Belgium working the processes would be able to supply us, thanks to which we should probably buy on more favourable terms. The patents were, therefore, revoked and the patentee ordered to pay applicants 45 guineas costs.

"There is another important decision concerning an application for revocation of a patent granted to Americans for a new lock-stitch sewing machine. The patentees urged, in defence, that the machine could not be made entirely here, because we in the United Kingdom had not the necessary tools nor the highly skilled labour that was requisite, and that they could, therefore, only manufacture parts of the machine here. The Comptroller-General held that this was not sufficient. To adequately work their patents, the patentees must not merely make certain parts of the machine here. The patent, therefore, would be revoked and 40 guineas costs awarded to the applicants."

FOREIGN TRADE OF ITALY.

Italy has figured so conspicuously of late in the forefront of public attention that a good deal of interest attaches to the review of her trade during the year 1907, which has just been issued, from the pen of Mr. A. Akers Douglas, Second Secretary to His Majesty's Embassy at Rome. From it we learn that the imports during the year under review were higher than they had ever been before, and that the total exports, though lower than those of 1906, far exceeded the average of the preceding five years. Trade and commercial activity, as might be inferred from the above, suffered no diminution in 1907, in spite of crises in a few industries, of numerous strikes, and of a certain depression in financial markets. The rapid development of national industry continues strongly supported by Government, and the textile industry in particular makes great progress. The wine crop was superabundant, causing much distress to growers who were unable to dispose of their large stocks, and prices were very low. There has been a demand for abolition of the *octroi* and the excise duties have been reduced. Sulphur has suffered from increased production in Louisiana, and in several mines work has been actually stopped, while in others the price has been substantially reduced. There was a decrease in the value of silk exported, this being the largest item of the export trade. The import duty on petroleum, which has been higher than in any other European country, was reduced 50 per cent. in April, 1907, viz., from 48 to 24 lira per quintal, and this was followed by a large increase in the imports.

Viewing the imports according to countries, it is very significant that England, which had always held the premier place, had in 1907 to yield to Germany, who is now the principal exporting country to Italy, having more than doubled its figures since 1903. The third country on the list, the United States, is also making equally rapid strides. Among the increased imports raw cotton, chiefly from America, figures conspicuously owing to the steady development of the textile industry in Italy. Wood is largely imported from Austria-Hungary for building purposes; this trade will probably increase as little wood is grown in Italy, and large forests have been cut down during the last thirty years. Among the increased imports of metals and machinery, agricultural machinery is now freely used in Northern Italy, especially when its great advantages for field-work begin to be appreciated. Since the State took over the railways large orders for rolling stock have been placed abroad, but the administration have now decided to give orders as far as possible to Italian firms. The importation of coal steadily increases, the United Kingdom, of course, heading the list. In the export of cereals, rice, flour, &c., there was an increase of nearly £3,000,000 in value as compared with 1906. Oil, however, fell off remarkably owing to the oil crop of 1906 having been one of the poorest on record. On the whole, the exports to and imports from the United Kingdom show a steady increase, though in certain categories there is a marked fall, this being noticeable in colonial goods, cereals, medicinal drugs, barks, &c.

HOME INDUSTRIES.

Child Labour.—As was to be expected, the Prime Minister made a very sympathetic reply to the representatives of public health authorities, who waited upon him last Friday, to submit to him resolutions adopted at the recent National Conference on Infantile Mortality. For the loss of child life remains appalling. Taking the last thirty years, while the general death-rate in the course of that period has diminished by one-half the infant mortality rate has remained practically stationary. One infant in every eight still dies in its first year. The Inter-Departmental Committee on Physical Deterioration reported that "the connection between infantile mortality and bad or insufficient feeding. . . . is, no doubt, established." But so also is the connection between bad and insufficient feeding, and the employment of mothers. Infantile mortality is due to many causes, of which unsuitable feeding is but one. It is, however, the chief cause, and it is inseparable from factory and workshop employment of mothers. During the Lancashire cotton famine, while privation increased the actual death-rate, the infant death-rate was greatly lessened owing to mothers being compelled to suckle their infants. And during the siege of Paris, while the general mortality was doubled, the infant mortality fell 40 per cent. from similar causes. The heart of the problem is the indifference, or the absence, of the mother. The industrial employment of married women leads them to consign the tendance of their infants, at a very early age, to young children, or strangers. The infants thus deprived of their mothers' care are habitually fed on diet ill adapted to their digestive powers, and are very frequently drugged with opiates, in order to allay the fractiousness arising from the illness induced by improper food. Nor does the evil end with the death of these children. The causes which produce these deaths weaken the survivors and reduce their chance of happy and useful life. The children, too, often come into the world but ill prepared to battle with illness. An occupation requiring a woman to stand during the greater part of the day, when continued up to a few days or even hours of the time of parturition, must act to the detriment of the offspring, and there is less chance of the child coming into the world fully grown, well formed, and in good health. In Germany, as in England, infantile mortality has reached terrible proportions. Of two million infants born alive each year over 400,000 die under the age of twelve months, and although the crusade against infantile mortality in Germany is still in the initial stages, experience has already shown the entire needlessness of a great part of the sacrifice of life which has been going on unchecked for so many years. The establishment of infant dispensaries and clinics, kitchens and milk depôts, the encouragement of natural feeding by the offer of money awards and the supply of milk, and the better supervision of foster and illegitimate children, are among the measures that have been taken. In this country, too, steps are being taken in the right direction, but the root of the evil is the absence of the mother in the factory or the warehouse.

British and German Workmen.—If the conclusions of Herr Paul Wagener, who contributes to the February report of the International Federation of Textile Workers' Associations a comparison between the British and German working classes, are to be accepted, the former are in much the better position. According to Herr Wagener, the number of working hours is in Germany 8 to 10 per cent. higher than in England, and the average weekly wages of Germany and England compare as 82 to 100. If the Englishman is paid 100s., the German gets only 82s.; but if the English working man spends 100s., the German has to pay for the same things 119s. So it seems that the English working man has 137s. for every 100s. the German has, and, therefore, the working man is in England 37 per cent. better off than in Germany. If it is taken into consideration that the working hours are longer in Germany than in England, and if the wages per hour are taken as a basis, then it will be found that the German gets only 75s. for every 100s. the Englishman has, and the result is that the English working man is 44 per cent. better off than the German. The German working man works more, earns less, and does not live so well as the English worker.

Working Hours in Shops.—On the face of it the argument in favour of the amendment of the Shop Hours Act is very strong. As the Home Secretary put it in his reply to the deputation from Manchester, that has just laid before him the case for the small retailer, there is an immense economic waste going on in the keeping open of shops where there are assistants simply from a competitive point of view, and not because very long hours are necessary for the amount of trade done in a particular day. There are scandalously long hours worked by assistants in some trades, and it is a monstrous thing that men and women—and young girls—should have to attend a shop from eight or nine o'clock in the morning till ten, or eleven, or twelve o'clock at night. Under the present Act, any Local Authority, after satisfying itself that two-thirds of the shops concerned are willing, can make a closing order, under the sanction of the Home Office, regulating the hours during which any class of shop may be open. But the difficulty of securing this two-thirds majority is very great. For example, in the New-cross Ward of Manchester, which has a population of 40,000, there are 1,028 retail grocers' shops, of which only 200 can afford to employ an assistant or an errand boy, leaving 828 shopkeepers who employ no assistant at all. In Bolton again, only 7 per cent. of the retail shops employ assistants, and the small shopkeeper, living behind or above his shop, has no objection to keeping open till late at night. Indeed, he feels his only advantage, as against the co-opera-

tive store and multiple shop, with its huge capital, is that of working longer hours. But in the long run he will have to give way and see a national standard set up to which all must conform.

Making a Market.—The British Consul is fond of telling the British trader that his want of enterprise is losing him valuable markets, and that the American trader is far ahead of him in ascertaining and supplying the requirements of these markets, but frequently the reports of American Consuls contain much the same warnings, addressed to American manufacturers and traders. For example, an American report from Tangiers, just published, complains, not that the American trader lacks enterprise, but that he does not trouble to gauge the market before trying to conquer it. He is the only one, says the Consul, who dares to attack a "market" in almost absolute ignorance of its condition. On the other hand, the German exporter, about to enter a new commercial field, sends his skirmishers out, usually men who secure employment in the business houses which are already in the field. Then he opens a dozen branch houses, and as managers of these branches are the men who have been clerking in rival houses, their future efforts are greatly assisted by many other men who have been travelling about the field, gathering information and samples. This information is utilised to the fullest extent, so that the man in charge of the exploitation of the new field knows every detail of conditions there. The samples are reproduced with an attention to detail, and a regard for truth which raises the German exporter to the rank of artist.

Cardroom Workers' Wages.—Whilst outside the textile trades the average wage of women in industry remains very low—it has been estimated, taking the average, to be about 7s. 6d. per week—within they have increased substantially in recent years. This is the case more particularly with cardroom workers. Twenty years ago a woman was thought to be doing well if she earned from 13s. to 14s. a week. But now, and more particularly in the newer mills, there are instances of female cardroom *employés* making nearly twice as much. The standard rates under the new universal list of prices vary from 18s. to 27s. per week, to which 10 per cent. increase has been added by the advances granted to the operatives during the recent "boom" in the cotton trade. Take roving-frame tenters, who among the grown-up women in the cardroom now earn the lowest wages. The standard length is 164 spindles per frame. On a pair of frames the standard pay is 20s. 9d. and 19s. 9d. on coarse counts, 18s. 11d. on medium, and 18s. on fine counts. And there is the 10 per cent. increase referred to above to be added to these amounts. On piece rates the amount of these wages may be exceeded. Generally the wages of roving-frame minders may be put at 22s. to 23s. per week. According to figures supplied to Mr. James Haslam, some women tenters are making more than 23s. per week, as high as 25s. 6d. In the newer mills, frames contain as many as 220 to 240 spindles per side, or from 60 to 80 spindles more than the standard length, they are run at a great speed, and they have other advantages to facilitate production. It is the custom for one woman to have charge of a pair of frames, and on the larger frames they complain of the greater strenuousness of labour. It would seem that under present drawing-frame conditions the work is getting too heavy for women. Girl back-tenters are receiving from 9s. to 13s. per week, which means that as half-timers at 12 years of age they would earn half these amounts, and the full amounts at thirteen years of age.

OBITUARY.

THE HON. DUDLEY FRANCIS FORTESCUE.—After a very brief illness the death occurred on the 2nd inst. of the Hon. Dudley Francis Fortescue in the 89th year of his age. Educated at Harrow and Trinity College, Cambridge, he sat as M.P. for Andover from 1857 to 1874, and he was also a Commissioner in Lunacy from 1867 to 1883. In 1861 he was elected a life member of the Society of Arts, in the work of which he continued to interest himself for many years. He served on the Council in 1875-6-7, presided at one Ordinary Meeting and took part in several discussions.

QUESTIONS AND ANSWERS.

ANSWERS TO CORRESPONDENTS.

On all communications must be written the name and address of the sender, not necessarily for publication, but as a guarantee of good faith.

Each question or reply should be written on a separate sheet of paper, and should bear such signature of the writer, and such address as he wishes to appear.

Questions which can be answered from the usual books of reference, will not be printed.

QUESTIONS.

MARINE DESIGNING BY GEOMETRICAL DRAWING.—Is anything known of marine designing by geometrical drawing, in contradistinction to the "fairing" process with batten spline and curve?—TORBAY.

EMBANKMENTS OF THE RIVER THAMES.—Has any work been published in recent years dealing with the embankments lining the Essex and Kent shores of the Thames which confine the river to its present channel?

Dugalde, Wren, and other writers hold that the embankments were built by British labour during the Roman occupation, and most modern historians of London seem to share this opinion.—LONDONIENSIS.

GRAIN ELEVATOR.—What is the ordinarily accepted connotation of this term? Is it used to include not only the apparatus for loading grain, but also the buildings in which the grain is stored, and sometimes even the whole financial system under which the grain so stored is dealt with?—IGNORAMUS.

WREN'S PLANS FOR RE-BUILDING LONDON.—Where can I find particulars of the plans which Wren drew up for re-building London after the great fire?—ADELPHI.

ANSWERS.

ANTICIPATION OF THE AEROPLANE.—The painter who wasted his time in trying to fly was Leonardo da Vinci, and the whole story is told in a charming novel written by the Polish writer, Meregkowski, entitled "The Forerunner," the facts being taken from Leonardo's diary.

There are many names for flying machines—aeroplanes, airships, aviators, helicoptères, ornithoptères, &c. Why not call them Icars, after poor Icarus who was killed in the first recorded experiment?—WILLIAM H. PREECE.

ANTICIPATION OF THE AEROPLANE.—It was Leonardo da Vinci, in the fifteenth century, who wrote about, and made designs for, artificial flight. As a matter of fact he did not design what is known as an aeroplane—but his projects were in the direction of imitating the wings of a bird. He also, however, made a small sketch of a vertically lifting screw propeller.

These were described in the "Aeronautical Annual" for 1895 (published in Boston, U.S.A.), and are referred to in several lives of this artist.—B. BADEN-POWELL.

DISTINCTION BETWEEN ENAMEL AND GLASS.—The distinction between glass and enamel is somewhat of the same nature as the difference between a publication and a book, for from the purely technical point of view glass includes enamel. It is difficult to give a satisfactory definition of glass, but it may be referred to as a complex compound of silica, characterised by an entire absence of any definite structure, which definition applies equally to enamels. I take it, however, that Mr. Lewis speaks of glass in the sense of a vitreous substance employed by itself to form various articles of use or decoration, as in the case of window-glass, glass bottles, and so forth, as distinct from enamels considered as a vitreous material employed in the form of a coating to other substances, as in the case of a pottery glaze. Considered from this point of view, enamel and glass may in the majority of cases be distinguished in respect of composition in that whereas glass consists of:—(a) Silica; (b) An alkali—soda or potash; (c) An alkaline earth—lime, magnesia, or baryta, enamel differs from it in one or both of the following:—1. The silica is partially replaced by boron oxide; 2. The alkaline earth is replaced by lead. In the time of the Romans this would have formed an accurate basis of distinction, but it breaks down hopelessly when we consider—(a) That "flint" glass—introduced in the seventeenth century, and nowadays largely used for making bottles, &c.—contains lead as an essential ingredient; (b) That optical glass—as used for lenses, &c.—contains both lead and boron; (c) That leadless glazes are now prepared; (d) That the enamel of stained glass in mediæval times differed scarcely at all in composition from the sheet-glass to which it was applied. In fact, as Sir Boverton Redwood says, there is no line of demarcation between the two as regards composition—under suitable conditions almost any glass may be used as an enamel, and the only distinction that can be drawn is one of employment rather than of nature.

With reference to the second part of the query, the only thing to prevent one from saying that the art of enamelling is as ancient as glass-making, would be a certain knowledge as to the exact date when each art was first practised. To my thinking, the evidence rather points to the fact that the making of articles of glass was subsequent to, and arose out of, the process of enamelling. At all events, the earliest glass that can be dated with certainty is that of Tel-el-Amama, about 1500 B.C., whereas glazed pottery of a much earlier date is known: in fact the manner in which the vases of this period were produced (by working the glass over a clay mould) suggests a tradition of enamelling. This clumsy method of making objects in glass persisted down to close upon Christian times, and it was probably not until late Grecian times that the use of the blow-pipe was discovered.—NOEL HEATON.

VIENNA LIME.—It is not surprising that lime merchants should be unacquainted with the "Vienna lime" referred to by "Builder," as the expression is a mistranslation of "Wiener Leim." This means Vienna *glue*, not lime, and merely indicates a good quality of glue. If, however, the recipe in which the material is mentioned should be an old one, isinglass might be meant, as Vienna was a great market for that commodity in the days when the sturgeon was of more frequent occurrence in the Danube than it is now. The lime used in Vienna differs but slightly from our own. The percentage of magnesia is sometimes high.—WALTER F. REID.

SHEFFIELD PLATE.—Mr. William Redman, in his "Handbook of Information on Pewter and Sheffield Plate," gives the following account of the origin of Sheffield Plate:—"In 1742 Thomas Bolsover, an ingenious mechanic, was repairing the handle of a knife, which was composed partly of silver and partly

of copper, when he accidentally fused the two metals. From this incident he found that it was possible to coat copper with silver, in such a way as to form a cheap and durable metal, producing only an exterior of silver, which might therefore be used in the manufacture of various articles in which silver alone has hitherto been employed. He at once commenced to manufacture articles made of this material (copper plated with silver), but confined himself to buttons, snuff-boxes, and other light and small wares. . . . A Mr. Joseph Hancock took up the new business of plating copper with silver, and he became very successful."—HALL-MARK.

GENERAL NOTES.

HENRY SAXON SNELL PRIZE.—The Henry Saxon Snell Prize, founded to encourage improvements in the construction or adaptation of sanitary appliances, and awarded by the Council of the Royal Sanitary Institute at intervals of three years, will be offered in the year 1909 for an Essay on "The Principles of Heating and Ventilating Public Buildings, with descriptive details and illustrations of the best systems." The prize consists of £50 and a medal of the Institute. The essay, which must contain not more than 5,000 words, must be delivered on or before August 31st, 1909, addressed to the Secretary of the Royal Sanitary Institute, 90, Buckingham Palace-road, London, S.W., from whom further particulars of the competition may be obtained.

THE PANAMA CANAL.—The New York correspondent of *The Times* writes as follows:—"The President's uncompromising statements endorsing the views of the Board of Engineers in favour of a lock canal for Panama are contested by the New York newspapers generally to-day. How far their views reflect the strength of the sentiment in favour of a sea-level canal one cannot easily gauge, but ample evidence of the wide existence of such a sentiment is furnished by the mutterings of Congress and by the constant attacks on the present plans published in the Press from outside critics. Some impatience is expressed at the President's implication that the engineers should be exempt from criticism. They are reminded of their miscalculations in the cost of the canal and of the many changes they have ordered in the plans, reversing their own earlier judgment. The *Evening Post* calls their various reports a sad record of uncertainty, while the *Tribune*, though remarking that it is high time for dissension and doubts to give place to cordial support of the enterprise and to cheerful confidence in its success, does not believe that every one will be convinced by the engineers' report, or will be persuaded that the sea-level plan is not the best."

FORESTRY AT OXFORD.—In view of the recent Report of the Royal Commission on Coast Erosion and Afforestation, a special interest attaches to the Report presented to Convocation, on the 23rd ult., by the Delegates for Instruction in Forestry at Oxford. The attendance of students during the year 1908 was 61 in Hilary and Easter terms and 76 in Michaelmas term. The number includes 12 private students, in addition to probationers for the Indian, Ceylon, Malay, and Sudan Forest services. The Maharajah of Mysore has sent one student, and another is an officer of the Central Indian States. The work of the year included, besides the usual lectures and excursions, a three weeks' tour among the French forests, conducted by Mr. Fisher. Fourteen students obtained the diploma in Forestry. The work of the Forest Garden and Experimental Plantations in Bagley Wood has progressed satisfactorily, and the area of the forest garden now covers 14 acres. St. John's College has provided a handsome building in Parks-road, containing a lecture theatre, a class-room, a library, a museum, a professor's room, and storage accommodation. The receipts for the year amounted to £4,603 4s. 4d. (including the annual grant of £395 from the Secretary of State for India), and a balance of £345 8s. 10d. has been carried forward to next account.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

MARCH 10.—"The Application of the Microscope to the Study of Metals." By WALTER ROSENHAIN. R. T. GLAZEBROOK, M.A., Sc.D., F.RS., Director of the National Physical Laboratory, will preside.

MARCH 17.—"The Musical Aspect of Drums." By GABRIEL G. CLEATHER. [The paper will be illustrated by short selections from the works of the great masters, with the assistance of Mrs. Stansfeld Prior at the pianoforte.] SIR CHARLES VILLIERS STANFORD, M.A., Mus.D., D.C.L., LL.D., will preside.

MARCH 24.—"Afforestation and Timber Planting in Great Britain and Ireland." By J. NISBET. The RT. HON. CHARLES W. DILKE, Bart., M.P., wil preside.

MARCH 31.—"St. Helena." By JOHN C. MELLISS, M.Inst.C.E., F.G.S.

Dates to be hereafter announced:—

"Railway Development in China." By ARTHUR JOHN BARRY, M.Inst.C.E.

"The Resources of Peru." By C. REGINALD ENOCK, F.R.G.S.

"The Foundations of Stained Glass Work." By NOEL HEATON, B.Sc., F.C.S.

"The Manufacture of Nitrate of Lime." By SAM EYDE.

"The Teaching of Design." By E. COOKE.

"Furniture Design and Construction—Ancient and Modern." By PERCY A. WELLS.

"The Principles of Heredity as Applied to the Artificial Production of new forms of Plants and Animals." (Aldred Lecture.) By PROFESSOR ARTHUR DENDY, D.Sc., F.R.S., F.L.S.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

MARCH 25.—"Native Man in Southern India." By EDGAR THURSTON, Superintendent, Ethnographic Survey, Madras.

APRIL 29.—"The Problem of Indian Labour Supply." By SELWYN HOWE FREMANTLE, I.C.S.

MAY 13.—"Some Phases of Hinduism." By KRISHNA GOBINDA GUPTA (Member of the Council of India).

MAY 27.—"The Function of Schools of Art in India." By CECIL L. BURNS, Principal of the Bombay School of Art. PROFESSOR SIR HUBERT VON HERKOMER, C.V.O., D.C.L., R.A., will preside.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock :—

MARCH 16.—"The Colonial Wool Trade." By S. BANKS HOLLINGS. LORD BRASSEY, G.C.B., will preside.

APRIL 6.—"Ceylon: its Industries and Material Progress." By the Hon. JOHN FERGUSON, C.M.G. The Rt. Hon. SIR WEST RIDGEWAY, G.C.B., G.C.M.G., K.C.S.I., will preside.

MAY 4.—

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

LEON GASTER, A.M.I.E.E. (Editor of the "Illuminating Engineer"), "Modern Methods of Artificial Illumination." (Four Lectures.)

LECTURE IV.—MARCH 8.—*General Problems in Illumination and Illumination Measurements.*—Daylight illumination and its variation — Intrinsic brilliancy of the different artificial illuminants—Effect on the eye — Methods of shading—Spectra of various illuminants—Physiological effects of light of different colours — The use of euphosglass — Modern methods of measuring light and illuminatio —International action regarding standards and units of light—Illumination and hygiene — The work of the Illuminating Engineering Society—The need of the illuminating engineer expert: description of his function—Concluding remarks and recommendations.

Each lecture will be fully illustrated by working specimens of the lamps and apparatus described.

GEORGE GERALD STONEY, M.Inst.C.E., "Steam Turbines." Three Lectures.

March 22, 29, April 5.

F. W. LANCHESTER, "Aerial Flight." Three Lectures.

April 26, May 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 8...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Leon Gaster, "Modern Methods of Artificial Illumination." (Lecture IV.)

Geographical, Burlington-gardens, W., 8½ p.m. Dr. M. A. Stein, "Explorations in Central Asia.", Surveyors, 12, Great George-street, S.W., 5 p.m. Mr. J. George Head, "Giant London—The Evolution of a Great City: its Growth in Size and Value."

TUESDAY, MARCH 9...Royal Institution, Albemarle-street, W., 3 p.m. Prof. F. W. Mott, "The Evolution of the Brain as an Organ of Mind." (Lecture III.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. L. A. B. Wade, "Concrete and Masonry Dam Construction in New South Wales."

Photographic, 66, Russell-square, W.C., 8 p.m. Mr. A. Callier, "Observation and Diffusion of Light by Photographic Negatives Measured by Means of Marten's Polarisation Photometer."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8 p.m. Mr. B. H. Morgan, "The Development of Empire, Trade and Industry."

Paint and Varnish Society, St. Bride's Institute, Fleet-street, E.C., 8 p.m. Mr. A. F. Suter, "Technical Notes on Lac."

WEDNESDAY, MARCH 10...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Walter Rosenhain, "The Application of the Microscope to the Study of Metals."

Biblical Archæology, 37, Great Russell-street, W.C., 4½ p.m.

Japan Society, 20, Hanover-square, W., 8½ p.m. Mr. A. Dobrée, "Chinese Characters: their Structure, and Methods of Indexing them."

United Service Institution, Whitehall, S.W., 3 p.m. Colonel F. G. Stone, "Defence of Harbours against Air Ships."

Malacological, Burlington-house, W., 7½ p.m. 1. Mr. F. G. Bridgman, "Description of a New Species of *Oliva* from the Andaman Islands." 2. Mr. H. O. N. Shaw, "Notes on the Genera *Cypræa* and *Trivia*." 3. Rev. H. A. Cooke, "The Shell Mound at Sidon. On the *habitat* of Certain Species of *Clausilia* from the Coast of Syria." 4. Staff-Surgeon K. H. Jones, R.N., "Note on the Species of *Cyclophorus* found at Hongkong." 5. Mr. C. Davies Sherborn, "The 'Conchological Illustrations,'" by G. B. Sowerby, jun., and the "Descriptive Catalogue of Shells," by J. E. Gray. 6. Mr. H. O. N. Shaw, "The Date of Issue of Sowerby's 'Conchological Illustrations.'"

THURSDAY, MARCH 11...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

African Society, Gaiety Restaurant, Strand, W.C., 8½ p.m. Address by the Earl of Crewe.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. A. D. Hall, "Recent Advances in Agricultural Sciences." (Lecture I.)

Electrical Engineers, 25, Great George street, S.W., 8 p.m.

FRIDAY, MARCH 12...Royal Institution, Albemarle-street, W., 9 p.m. Mr. S. G. Brown, "Modern Submarine Telegraphy."

Physical, Imperial College of Science, South Kensington, S.W., 8 p.m. 1. Mr. A. E. Garrett, "The Effect of Radiation on the Brush Discharge." 2. Mr. E. C. Snow, "Pirani's Method of Measuring the Self-Inductance of a Coil." 3. Mr. W. S. Tucker, "Exhibition of a High Potential Primary Battery." 4. Mr. H. S. Rowell, "The Least Moment of Inertia of an Angle Bar Section."

Astronomical, Burlington-house, W., 5 p.m.

SATURDAY, MARCH 13...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Sir J. J. Thomson, "The Properties of Matter." (Lecture III.)

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, MARCH 17th, 8 p.m. (Ordinary Meeting.) GABRIEL G. CLEATHER, "The Musical Aspect of Drums."

Further particulars of the Society's meetings will be found at the end of this number.

COLONIAL SECTION.

It has been found necessary to postpone the meeting of the Colonial Section announced for the 16th inst., at which Mr. S. Banks Hollings was to have read a paper on "The Colonial Wool Trade." The paper will be read next Session.

A meeting of the Section will be held on April 20th, when the Hon. Charles Gideon Murray will read a paper on "South Africa."

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1909 early in May next, and they, therefore, invite members of the Society to forward to the Secretary, on or before Saturday the 4th April, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce," and has been awarded as follows in previous years :—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S.

In 1865, to his Imperial Majesty, Napoleon III.

In 1866, to Michael Faraday, D.C.L., F.R.S.

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S.

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S.

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For.Memb.R.S., Chevalier of the Legion of Honour, &c.

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I.

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B.

In 1872, to Mr. (afterwards Sir) Henry Bessemer, F.R.S.

In 1873, to Michel Eugène Chevreul, For.Memb. R.S., Member of the Institute of France.

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S.

In 1875, to Michel Chevalier.

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal.

In 1877, to Jean Baptiste Dumas, For.Memb.R.S., Member of the Institute of France.

In 1878, to Sir Wm. G. Armstrong (afterwards Lord Armstrong), C.B., D.C.L., F.R.S.

In 1879, to Sir William Thomson (afterwards Lord Kelvin), O.M., LL.D., D.C.L., F.R.S.

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S.

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin.

In 1882, to Louis Pasteur, Member of the Institute of France, For.Memb. R.S.

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.

In 1884, to Captain James Buchanan Eads.

In 1885, to Mr. (afterwards Sir) Henry Doulton.

In 1886, to Samuel Cunliffe Lister (afterwards Lord Masham).

In 1887, to HER MAJESTY QUEEN VICTORIA.

In 1888, to Professor Hermann Louis Helmholtz, For.Memb.R.S.

In 1889, to John Percy, LL.D., F.R.S.

In 1890, to Dr. (afterwards Sir) William Henry Perkin, F.R.S.

In 1891, to Sir Frederick Abel, Bart., G.C.V.O., K.C.B., D.C.L., D.Sc., F.R.S.

In 1892, to Thomas Alva Edison.

In 1893, to Sir John Bennet Lawes, Bart., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S.

In 1894, to Sir Joseph (afterwards Lord) Lister, F.R.S.

In 1895, to Sir Isaac Lowthian Bell, Bart., F.R.S.

In 1896, to Professor David Edward Hughes, F.R.S.

In 1897, to George James Symons, F.R.S.

In 1898, to Professor Robert Wilhelm Bunsen, M.D., For.Memb.R.S.

In 1899, to Sir William Crookes, F.R.S.
In 1900, to Henry Wilde, F.R.S.
In 1901, to His Majesty the King.
In 1902, to Professor Alexander Graham Bell.
In 1903, to Sir Charles Augustus Hartley, K.C.M.G.
In 1904, to Walter Crane.
In 1905, to Lord Rayleigh, O.M., D.C.L., Sc.D., F.R.S.
In 1906, to Sir Joseph Wilson Swan, M.A., D.Sc., F.R.S.
In 1907, to the Earl of Cromer, O.M., G.C.B., G.C.M.G., K.C.S.I.
In 1908, to Sir James Dewar, M.A., D.Sc., LL.D., F.R.S.

A full list of the services for which the medals were awarded was given in the last number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURE.

On Monday evening, March 8th, Mr. Leon Gaster, A.M.I.E.E., delivered the fourth and last lecture of his course on "Modern Methods of Artificial Illumination." The lecture was illustrated with apparatus kindly lent by the following firms :—

The Bryant Trading Syndicate, Limited.—Transformer for experimental purposes.

The Chloride Electrical Storage Company, Limited.—Loan of a small battery of accumulators to supply current to Bechstein Flicker Photometer.

Messrs. Everett, Edgcumbe and Company, Limited.—Example of Trotter Universal Photometer, and Portable "Watt-Photometer."

Messrs. Elliott Brothers.—Example of Harrison Universal Photometer, adapted to measurements in a horizontal plane.

Messrs. Franz, Schmidt and Haensch (Berlin).—Martens ilumination-photometer; Thorner illumination-tester; Bechstein flicker-photometer (electrically driven); Bechstein contrast photometer.

The Gas Light and Coke Company (Mr. F. W. Goodenough)—Series of incandescent gas burners, equipped with various types of artistic diffusing shades, for interior lighting.

The General Electric Company, Limited. — Large type of multiple high candle-power metallic filament lamp fixture, and single high candle-power "Osram" lamp fitting.

The Holophane Glass Company. — Examples of types of holophane shades and reflectors for use with gas and electric light fittings.

Messrs. Marples, Leach and Company, Limited.—Special arc lamp for photographic purposes.

Messrs. Millar and Weltch, Boston (United States of America).—The Williams "Simplex" photometer.

Messrs. Gebr. Putzler (Penzig, Schles., Germany).—Specimen sheets of "Euphos" glass opaque to ultra-violet light, in four grades of opacity; examples of chimneys and glow-lamp bulbs composed of "Euphos" glass.

Messrs. Julius Sax and Co., Limited.—Electric fittings and glassware for artistic and decorative indoor illumination.

Messrs. W. Watson and Sons.—Fluorescent barium platinocyanide screen; samples of "Uviol" and "Uranium" glass; specimens of Jena flint glasses opaque, and transparent to ultra-violet rays respectively.

[All these exhibits were shown in actual operation.]

Special thanks are also due to Drs. K. Stockhausen and F. Schanz, of Dresden, the inventors of the "Euphos" glass, who kindly arranged for the exhibit of the specimens mentioned above, and also sent a series of lantern-slides illustrating their properties.

Acknowledgment must also be made of the courtesy of the City and Guilds of London Central Technical College for kindly sanctioning the loan of some apparatus, including a photometrical bench, specimens of uranium glass, &c.

A vote of thanks to the lecturer was passed unanimously on the motion of the Chairman.

The lectures will be published in the *Journal* during the summer recess.

THIRTEENTH ORDINARY MEETING.

Wednesday, March 10, 1909; R. T. Glazebrook, M.A., Sc.D., F.R.S., Director of the National Physical Laboratory, in the chair.

The following candidates were proposed for election as members of the Society :—

Arbuthnot, Lieut.-Colonel G. H., care of Messrs. H. S. King and Co., 9, Pall-mall, S.W.
Buck, Sir Edward Charles, K.C.S.I., LL.D., care of Messrs. H. S. King and Co., 65, Cornhill, E.C.
Dunlop, David John, Inch Works, Port Glasgow, Scotland.
King, Henry, F.R.H.S., 100A, Queen Victoria-street, E.C.
Sherali, Hon. Shaikh Sadikali, Khairpur, Sind, India.

The following candidates were balloted for and duly elected members of the Society :—

Beszant, Frederick Henry, 2, Monument-street, E.C.
Coker, Herbert Spencer, District Commissioner, Department, Warri, Southern Nigeria, West Africa.

Leigh, Herbert Hamilton, H.M. Treasury, Warri, Southern Nigeria, West Africa.
Lloyd, G. M., M.A., M.Sc., The Limes, 7, Pepys-road, Raynes-park, S.W.
Kurup, M. N. Paramaswara, The University, Birmingham, and Manaloor House, Olashà, Kottayam, Travancore, India.
Ralli, Dosabhoy Cowasji, care of The Commercial Bank of Scotland, 62, Lombard-street, E.C.

The CHAIRMAN, in introducing the reader of the paper, said he had recently been reminded, in looking through some old papers, that one of the earliest series of lectures on the subject with which Mr. Rosenhain's paper dealt was that given by the late Sir William Roberts-Austen before the Society of Arts in 1893 or 1894, and since that time the importance of the subject had been more and more realised, and interest in it had greatly grown. Nearly ten years ago, when he was called upon to take up his position at the National Physical Laboratory, the late Sir William Roberts-Austen very strongly impressed upon him the importance of the work, and urged that, as soon as possible, the Laboratory should take up the work of the Alloys Research Committee of the Institution of Mechanical Engineers, of which for so long Roberts-Austen had been the Chairman and the main investigator. In a lecture which he (the Chairma) gave at the time before the Royal Institution on the aims of the National Physical Laboratory, he was able to refer, even at that early date, to Mr. Rosenhain's important work, which had been brought beore the notice of the Royal Institution in a lecture by Professor Ewing. Mr. Rosenhain had continued the work up to the present time, and the paper gave some of the most recent developments and results which had been obtained.

The paper read was—

THE APPLICATION OF THE MICROSCOPE TO THE STUDY OF METALS.

By WALTER ROSENHAIN.

In addressing the Royal Society of Arts on the subject of the microscopic study of metals, I feel that I am continuing, in a small measure, the work of a very eminent predecessor. In his Cantor Lectures on "Alloys," the late Sir William Roberts-Austen dealt, at some length, with the microscopic side of the subject, and I hope to indicate, in the present paper, some of the developments which have taken place in this subject during the twelve years that have elapsed since the date of Roberts-Austen's lectures here. To all those familiar with the subject it is evident that the work of Roberts-Austen lives and acts as an inspiration for much of the best work of to-day. Although I, myself, had not the privilege of being one of his students, I feel that I owe so much to his work, and to his personal kindness and stimulus, that I could not open a paper on this subject and in this place, without some reference to a man who was, in his day, one of the foremost workers in this field.

The uses of the microscope, in the study of metals, are of several distinct kinds. I am not so much referring to the distinction between the scientific and the practical aspects of the subject, as to that between the different branches of the subject, each and all of which, however scientific they may appear, have considerable importance from the practical point of view also. A complete knowledge of metals—and particularly of those metals which are employed for practical purposes—includes, in the first place, a complete knowledge of their chemical constitution, a knowledge not only of the chemical elements present, and their quantitative proportions, but also of the manner in which they are combined, and the relative arrangement of the various constituents; in obtaining this knowledge the microscope has proved an invaluable ally to the study of metals and alloys by the aid of the pyrometer and by other methods of investigation. Further, we require to know the defects or "diseases" to which metals may be subject, and in obtaining a knowledge of what might be termed the "structural pathology" of these defects or diseases the microscope is essential, while it provides us with an almost unfailing means of diagnosing these diseases on the occasions when a "post-mortem" examination of a broken or damaged object is required. Finally, we require to know something of the physical internal structure of our metals — of the intimate nature of their structure—of the growth and mode of formation of crystals and of the manner in which these crystals undergo the varied changes of shape which are so constantly applied in metals; and here again the microscope has thrown light into places that were formerly dark, and has furnished a clear explanation of the phenomena of plastic deformation and of fracture under fatigue or shock—explanations which, when more fully realised by metallurgists and engineers, will lead to a better understanding and a more rational control of the every-day phenomena of metals.

In studying the chemical constitution of alloys the microscope enables us to determine with considerable accuracy to which of a small number of possible categories any specimen of alloy may belong. For instance,

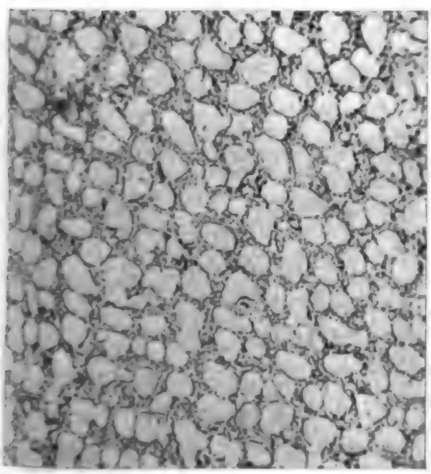
the class of pure metals and pure inter-metallic compounds always possesses a very definite and characteristic structure—they are simply aggregates of minute crystals, all of which are of the same kind, merely differing from one another in respect of the orientation of their respective crystalline planes. These crystalline planes are not, as a rule, obvious when a section of metal is observed by reflected light, since the boundaries of the crystals are not of geometrical form. The external geometrical form of a crystal is only developed when the crystal is formed either in a free liquid or in a very plastic solid; in a solidifying metal, however, the growing crystals interfere with one another, and their final boundaries are simply the surfaces upon which they met when growing outwards from their respective centres of crystallisation. In section, such a structure appears as a network of irregular polygons, but when suitably etched, the crystalline orientation of each of these polygonal areas becomes manifest by a peculiar appearance specially evident when the section is viewed under oblique light. So characteristic is this appearance that it has received the name of "oriented lustre," and it may be readily observed on a large scale by "etching" a smooth piece of tin plate in strong hydrochloric acid. A piece of cast lead, etched in dilute nitric acid for some time, also shows this feature on a relatively enormous scale; in such a metal as iron, on the other hand, the crystals are usually so minute that they can only be seen clearly under a magnification of 200 diameters.

A second class of metallic bodies frequently possesses a micro-structure very similar to that of pure metals or pure compounds; these are the bodies known as "solid solutions." These are alloys in which the state of mutual solution of the two component metals which exists in the liquid state persists unchanged in the solid, crystalline state. The term simply implies a solution which—unlike a great many solutions—has solidified without undergoing any separation of its components. Many of our most useful alloys, such as the best varieties of brass and bronze, are examples of this class of alloy. As their micro-structure is so very similar to that of a pure metal, they cannot be readily distinguished from pure metals except by the aid of chemical analysis, but in some cases their structure shows traces of their more complex nature. Although it is typical of these bodies that in their final solid condition, if sufficiently slowly cooled, the state of intimate mixture of their component metals is the same as it was in the liquid solution from which they were formed, there is none the less a certain amount of separation which takes place temporarily during the freezing process, and if this has been carried on rather rapidly, complete equilibrium may not be attained, and the resulting structure, although consisting of an aggregate of "polygonal" crystals, may yet show traces of layers of varying composition within each of these crystals—and this is a feature which can usually be seen in any rapidly-cooled solid solution.

A considerable number of solid solutions of this kind, which are formed and remain stable at high temperatures, become unstable at lower temperatures and tend to deposit crystals of a new constituent, much as hot saturated salt solutions often tend to deposit crystals of the salt during cooling; in some cases this is a gradual process, but in many cases the change takes place at a definite temperature, which is then known as a critical or transformation temperature. One of the best-known of these changes is that which takes place in ordinary carbon steel when the carbon passes out of the solid solution in which it remains down to 680° C. and separates in the form of plates or crystals of carbide of iron. It is the suppression of this change by sudden cooling or quenching which results in the hardening of steel. As a rule, however, the quenching process is not sufficient to suppress entirely any of these changes—the most rapid mode of cooling still allows several seconds to elapse between the commencement of cooling and the time when the metal is so cold that its molecules can no longer re-arrange themselves with any degree of rapidity. For practical purposes this slight amount of change in the case of steel is rather an advantage than otherwise, since in the subsequent "tempering" of steel by gradual re-heating, this very change is partially brought about in order to restore some of its toughness to the steel. For experimental purposes, however, where the object of quenching is to stereotype, as nearly as possible, the structure existing at any given high temperature in order to obtain an insight into the various changes and re-arrangements which occur during slower cooling, it is essential that the quenching process should be as rapid and vigorous as possible, and that it should take place at a definitely known temperature, while the preliminary heating of the

specimen of metal should be carried out in such a way as to avoid oxidation or other chemical action. For this purpose I have devised a special apparatus in which the specimen of metal—in the form of a small rod or disc—is heated *in vacuo* in a tube of fused quartz which passes through a small electric resistance furnace. The exhausted tube communicates by means of a large tap with a vessel containing water or other quenching liquid, and when the desired temperature has been reached—as indicated by means of a thermo-couple placed in contact with the specimen—the heating current may be switched off and the large tap opened. Under the pressure of the atmosphere the water rushes into the heated silica tube and washes the specimen down into a large receiving flask at the other end. The silica tube is not injured by this treatment, and there is no risk of explosion when the apparatus is correctly proportioned. [The apparatus was shown in action.]

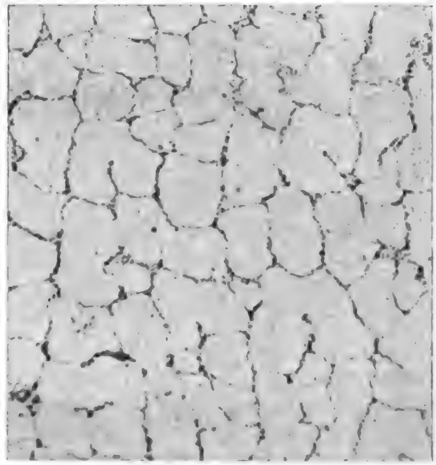
FIG. 1.



ALLOY OF TIN WITH 10 PER CENT. OF LEAD.
The presence of the dark eutectic constituent is seen.

The third class of alloys are those which show a duplex structure. In these bodies the state of mutual solution of the two metals which exists in the liquid state is more or less completely broken up in the solid state; on cooling, the predominating constituent crystallises out of the fusion until finally the remaining mother-liquor is enriched up to a definite limiting value which is also reached at a definite limiting temperature—then the mother-liquor solidifies in the form which is well-known as that of the "eutectic" alloy. The resulting structure of such alloys consists of crystals of the predominating metal embedded in the "eutectic." The series of lantern-slides shown (three of which are reproduced here) serve to illustrate the structures resulting from this mode of solidification of some of the alloys of lead and tin, commencing from an alloy containing only 1 per cent. of lead and continuing up to an alloy containing 80 per cent. of lead.

FIG. 2.



ALLOY OF TIN WITH 20 PER CENT. OF LEAD.
The eutectic constituent is present in large proportions.

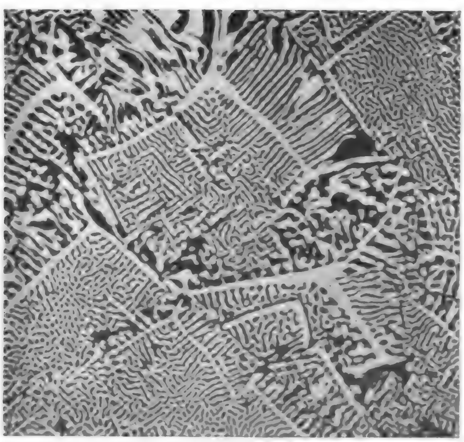
FIG. 3.

ALLOY OF TIN WITH 55 PER CENT. OF LEAD.
A crystal of the lead constituent is seen embedded in the eutectic constituent.*

* Reprinted, by kind permission, from the "Philosophical Transactions" of the Royal Society.

The manner in which the proportion of eutectic increases to a maximum and then again decreases as the percentage of lead increases, is very evident. I may perhaps add that I have chosen these illustrations from the alloys of lead and tin partly because they have formed the subject of a quite recent research by Mr. P. A. Tucker and myself, but principally because the freezing-point curve of these alloys was given and explained in the Cantor lectures of Roberts-Austen. At that time it was not possible to prepare the softer alloys of this group, viz., those near the lead end of the series, for microscopic examination; no suitable process of polishing had yet been discovered. The work of certain eminent French metallographers, principally of Monsieur Henri Le Chatelier, has led to the development of

FIG. 4.



EUTECTIC ALLOY OF BISMUTH AND TIN, SHOWING THE CHARACTERISTIC LAMINATED STRUCTURE OF EUTECTIC ALLOYS.

methods of polishing which are applicable, with the aid of much care and delicacy of manipulation, even to the softest metals and alloys. The photographs here shown are examples of the results attained in this way.

The second constituent of the class of alloys just referred to, generally known as a "eutectic" alloy, as has already been mentioned, is an intimate mixture of crystals of the two metals which are present in the alloy. The exact nature and constitution of these bodies, however, presents a number of interesting questions, some of which have yet to be answered. Perhaps the most important of these questions is that of their true internal structure. In a large number of cases these eutectic bodies appear to possess a well-defined lamellar structure, such as that shown in the lantern-slides (one of which is reproduced in Fig. 4), but it must be borne in mind that such a laminated structure is not necessarily associated with eutectic alloys, and that this form of structure can be readily removed in most cases by suitable heating and cooling processes. All that can be said is that when cooled somewhat rapidly from fusion these alloys tend to assume a laminated structure. But what is this laminated structure? According to one view, put forward by such an authority as Dr. J. A. Ewing, the laminar structure results from a process of oscillatory solidification, minute layers of each constituent solidifying alternately. This view would imply a structure consisting of independent crystals of the two metals juxtaposed in layers. While it cannot be said that this type of structure does not occur in any eutectic alloys, it is certainly not found in a number of typical eutectic bodies which have recently been examined at the National Physical Laboratory. It has been clearly shown in the case of the eutectic alloy of lead and tin, in connection with the research on these alloys already referred to that the metal consists of crystals of that metal which is present in the largest proportion (by volume as well as by weight), and in the interstices of these crystals—that is in the spaces between the dendritic arms of these crystals —the other metal has been forced to solidify. The actual crystals of tin, in this case, appear to be spherulitic, and large crystals or grains possessing a definite system of crystalline orientation can be recognised. In other eutectic alloys subsequently examined such as the eutectics of copper-silver, bismuth-tin, bismuth-lead, lead-cadmium, bismuth-cadmium and tin-cadmium, other forms of crystallization have been met with, but the actual structure, as revealed by microscopic methods arranged for this study, is always consistent with the view that the metal present in large quantity acts a predominant partner and forms a crystalline network, in the interstices of which the other constituent is forced to solidify. Quite recently my attention has been drawn by Mr. G. H. Beilby, F.R.S., and Mr. Sheffield, of Dublin, to the very striking analogy which exists between the detail forms assumed by laminated eutectic alloys and the forms assumed in certain circumstances by thin films of liquids under the action of surface-tension. Mr. Sheffield has, in fact, sent me a microscopic slide, produced

allowing a liquid, containing fine particles of carbon in suspension, to evaporate on a slip of glass, and the structure of the residual film of carbon is so strikingly like some photomicrographs of the lead-tin eutectic alloy, that it is difficult to avoid the inference that there must be some analogous forces at work in both cases. Some speculation on this subject offers certain points of interest; thus the play of surface-tension forces may arise from the great softness of the newly-formed dendritic crystals of tin as they exist immediately after their own solidification, and during the solidification of the lead constituent. On the other hand, the work of Quinke suggests that there may be an actual separation of the two constituents, while still in the liquid state, just above the freezing point—a separation into a sort of finely-divided emulsion, the form of each particle, however, being governed by surface-tension forces.

While, at first sight, these questions and speculations as to the intimate nature and mode of solidification of eutectic bodies may appear to be of somewhat academic interest, a little further consideration will show that they involve issues of considerable practical importance. In the first place, it is necessary to bear in mind the fact that a great many most important industrial alloys consist in part of eutectic bodies—steel being one of this group—and that these alloys owe their valuable properties, as apart from those of the pure metal from which they are derived—in large measure to the presence and properties of the eutectic body—these eutectic constituents act as a strengthening, stiffening, and hardening influence on the alloys. But the exact properties of the alloy vary enormously according to the exact condition of the eutectic, and this condition is to be controlled by metallurgists by a correct adjustment of the thermal and mechanical treatment of the alloy, from the moment of its initial solidification onward. The proper methods of such control may be and in fact are to a certain extent ascertained by direct empirical methods—various forms of treatment are tried and that which gives the best results is adopted. But a deeper insight into the internal structure of these eutectic bodies and into their behaviour during solidification and under subsequent thermal and mechanical treatment is bound to supplement and extend the empirical knowledge already available and thus serve to extend the control of the metallurgist over the metals he manipulates. Thus, for example, the great influence which the temperature at which a fluid metal is poured into the mould when castings are being produced exerts upon the subsequent properties of the alloy is well-known and recognised, and this influence with all its wide-spreading consequences is generally ascribed to "the effect of the rate of cooling." But this is a vague expression and unsatisfactory even in its vagueness, since—in view of the ideas outlined above—it may be quite possible that mechanical agitation of a fluid metal to a temperature very close to its freezing-point may very seriously affect the resulting crystallisation—for good or ill. A more intimate knowledge of all that occurs during solidification, and particularly during the freezing of eutectic alloys, may therefore throw much light upon metallurgical processes which are more or less obscure to-day.

The question of the "Structural Pathology" of metals is a very large one and can only be touched upon in the briefest outline in the present paper. Just as an intimate knowledge of normal anatomy and physiology is essential as a preliminary to the study of pathology, so an intimate knowledge of the "normal" structure of metals is necessary for the diagnosis of disease or "abnormal" conditions. The difficulty in this direction arises from the fact that the internal structures of many metals are almost Protean as regards the changes which they can undergo, and in many cases the variations of properties which accompany these changes of structure find their special applications. The question of the "normality" of a given structure is therefore dependent upon the purpose for which the material is intended.

Broadly speaking, the diseases of metals are of three distinct kinds or classes, according to the nature of the causes which produce them. The first class may be called "diseases of treatment," since they embrace metal which, while of correct composition and otherwise of satisfactory quality, has been rendered weak or unsuitable by the thermal or mechanical treatment to which it has been subjected, either by those who produced it or those who used it. The second class may be termed "diseases of composition," since these arise from the presence in the metal of substances which either should not be there at all or which should only be present in smaller quantities. Finally, the third class includes "diseases of decay" arising from

the action on the metal of outside causes, either chemical or mechanical, leading to deterioration. While it is not claimed that microscopic examination will infallibly reveal any or all of these defects, particularly when applied to fragments of some broken object, it is certainly possible in very many cases to obtain microscopic evidence which throws much light on the causes of failure, particularly if the microscopic evidence is systematically correlated with the results of the most exhaustive mechanical tests which can be applied to the available material.

In the space available in the present paper only one or two examples of each of the classes of defects named above can

Fig. 5.

The two halves of the figure show the structure of the same kind of Brass seen under the same magnification in the case of two tubes.

That represented by the right-hand half of the figure is normal, that of the left-hand half excessively coarsened by undue heating.

be briefly enumerated. Thus, as regards diseases of treatment, it is sometimes found that steel which has unaccountably failed in practice possesses an unduly coarse structure. As a rule, such a coarse structure results from exposure of the steel to excessive heat, during the forging, welding, or annealing operations to which it has been subjected. In such cases, the microscopic determination of the cause of failure is readily made. Other metals may also possess an unduly coarse structure as a result of improper thermal treatment; thus Fig. 5 shows micrographs of sections from two brass tubes, one of which gave service while the other failed soon after being taken into use. The two photographs are taken at the same magnification and indicate the extent to which the structure of the bad tube has been coarsened by undue heating.

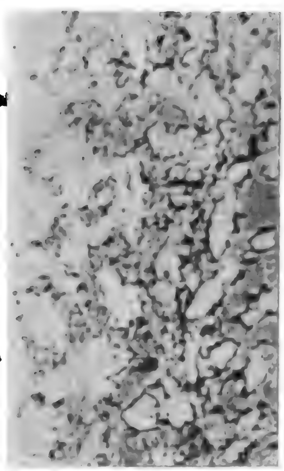
In regard to the injurious influence of impurities it must be said at the outset that examples of failure definitely traceable to this cause are more rarely met with, principally because metallurgical methods render it easier for the manufacturer to eliminate impurities from his products, while chemical analysis has long afforded a means of readily detecting their presence. On the other hand, failures arising from the presence of impurities are unknown. Thus, in commercial steel, and even in the best qualities of this excellent material, enclosures of certain impurities are met with very frequently when the material is examined under the microscope. These impurities are minute globules or thin rods of sulphide of manganese and silicate of either iron or manganese or both. These impurities are ordinarily looked upon as harmless, and in many cases the behaviour of test-pieces cut from steel showing these enclosures appears to confirm this view. On the other hand, in such various articles as crankshafts, gun-tubes and rails, instances have been observed both by the writer and others where the presence of enclosures in steel has, in unfavourable circumstances, led directly to failure in service. Once the fact that the presence of these impurities may act as a source of danger is realised, there can be little doubt that steel-makers will adopt means for their elimination or reduction to safer limits than those occasionally met with in present practice.

Finally, as regards the decay of metals brought about by mechanical or chemical means, a multitude of examples is met with in practice. The majority of these cases, however, arise from the use of unsuitable materials for specific purposes. Thus the "decay" of metals under fatigue, brought about by alternating stresses or vibration may generally be traced to the employment of either too soft a material or of too small a section, and consequently of too severe a range of stress. The defects arising from corrosion are more difficult to avoid, since the exposure of metals to sea and mine-water, and to still more corrosive liquids cannot always be avoided. But even here a study of the manner in which corrosion occurs in different metals and alloys is interesting and instructive. Thus in the case of brass the mechanism of decay consists in the gradual and progressive removal of the zinc

from the metal. In the case of a brass belonging to that range of alloys which possesses a duplex structure, that constituent which is richest in zinc, known as the β constituent, is attacked first and deprived of its zinc, a spongy mass of copper and copper oxide being left behind in the original form of the metal, but, of course, entirely deprived of strength. A section cut through a thick piece of brass in which this removal of the zinc has only penetrated a portion of the thickness of the metal reveals the whole mechanism very clearly. This is illustrated in Fig. 6.

The study of the internal physics of metals by the aid of the microscope is the last aspect of the subject to which reference is to be made here. Again, only the briefest outline is possible.

Fig. 6.



Section through the edge of a piece of "decayed" Brass.

The section is polished, but not etched, the dark regions being those from which zinc has been removed by corrosive action.

The fact that both pure metals and alloys are aggregates of minute crystals is now so well established and generally accepted that there is no need to review the evidence here. But the acceptance of the fact that metals are crystalline aggregates immediately raises certain important questions. Thus, most of the industrially useful metals possess in a marked degree the property of plasticity, *i.e.*, they are capable of undergoing very considerable permanent changes of shape without fracture, as, for instance, when a cold bar of steel is bent and twisted into the form of a knot in the manner sometimes adopted for exhibition purposes. To persons accustomed to think of "crystalline aggregates" in connection with such brittle materials as sugar or granite the suggestion that this pliable metal is also crystalline may at first appear surprising. But, on the other hand, the essential character of crystal-hood, viz., internal molecular symmetry or arrangement, has been shown to exist in materials so soft as to assume a spherical form under the action of surface-tension—bodies which have received the name of "liquid crystals." The plastic metals form a group of wide range between these two extreme classes of crystalline substances, and it may be added that such bodies as glacier ice and limestone rock form intermediate links in the series. The plastic metals, however, lend themselves especially well to ths study of the manner in which crystalline aggregates can and do undergo plastic deformation. This process has been clearly shown to consist in the occurrence of a series of very minute slips on some of the gliding or cleavage planes of the crystals constituting the aggregate in question; in this process the minute crystalline elements of which we may conceive each of the actual crystals to be built up, undergo no change of shape, but merely a displacement relatively to their neighbours in the system. In many cases this displacement seems to be a pure movement of translation, but in others it seems that these minute crystal-elements or molecular groups can swing round into alternative positions of symmetry and equilibrium by a process, well-known to mineralogists as "twinning." In both cases, however, the final result is to leave each crystal still a crystal after permanent deformation, merely differing from its former condition by the displacement of some of its constituent elements, but without any general disorganisation of its crystalline arrangement. Experimentally this process reveals itself if a section of a ductile metal, such as lead or iron, be first prepared for microscopic examination; if such a specimen be subsequently subjected to plastic deformation, the minute slips which occur in the various crystals, appear upon the previously plane surface as minute steps. When viewed with the microscope, under ordinary illumination, these steps appear as fine black lines or bands cross-hatching what were previously the plane surfaces of the crystals. The fact that these black lines are really due to steps in the surface, can be demonstrated optically by examining them under light falling upon

them at varying incidence, but a still more conclusive proof of their nature has been obtained by the production of an actual cross-section of surfaces upon which these lines or "slip bands" have been previously developed—these cross-sections were obtained by first embedding the specimen of metal in a deposit of electrolytic copper, and thus protecting the edge of the original surface from injury during the subsequent sectioning process. In these cross-sections the fact that the slip-bands are really steps, becomes unmistakably evident.

The microscopic study of metals has thus revealed an important fact in the micro-physics of metals and of crystalline aggregates in general. The consequences of this generalisation have as yet been worked out only in a few special directions. The most interesting of these is the application of the knowledge of the mechanism of deformation by slip to the explanation of the phenomena of fatigue in metals.

The phenomena of fatigue are, in their general features, so well-known that we need only recall here the fundamental fact that under a load or stress which would be quite insufficient to break a given piece of metal if applied steadily and continuously, the same piece of metal will fail after a longer or shorter period of time if the stress be applied in an alternating manner, varying from compression to tension or even varying from zero to its maximum value. The researches of Ewing and Humfrey, subsequently extended and confirmed by the work of Stanton and Bairstow, have furnished the key to these, at first sight, surprising facts. The explanation is based on the recognition of the mechanism of deformation in metals by the process of slip which was briefly outlined above. When a stress is applied to a piece of metal which is still far from sufficient to bring about a general plastic yielding, it may and in fact frequently does happen that owing to want of uniformity in the material or to want of uniformity in the distribution of the stress, a few of the crystals of the metal which happen to be unfavourably situated for meeting this particular stress, yield to it to a slight extent, and this yielding takes place by a small amount of slip occurring in these crystals. If the stress remains constant nothing further occurs, but if the stress be reversed the slip will also be reversed, and this repetition of slip, backwards and forwards over the same gliding planes, will recur with every alternation of stress. Now when such slipping occurs once only and to a moderate extent, it is sufficiently near the truth to say that the slip occurs without any disarrangement of the crystalline orientation of the molecules, but even then a certain very small amount of disarrangement occurs at the actual surface of slip—the mere rubbing of a piece of cloth over the surface of a piece of metal is sufficient to bring about certain molecular displacements at the surface and to set free temporarily some of the molecules near the surface, allowing them to rearrange themselves in new configurations. In the interior of a metallic crystal, therefore, where sliding occurs under great mutual pressure, some such displacement of molecules lying in or near the surface of slip must also occur. If the slip only takes place once, the molecules thus disturbed are not only comparatively few in number but they rapidly re-arrange themselves in the crystalline system from which they have been temporarily disturbed; if, however, the slip be repeated, not only are the molecules first disturbed prevented from returning to their normal positions, but fresh groups of molecules are disturbed at each repetition, until the continuity of the material is locally destroyed and a fissure is formed—the material has, in fact, disintegrated itself by the continued friction on the surfaces of slip. Nor must this account of the disintegration process be regarded as speculative; the whole process can be followed step by step—the first occurrence of slip in a few isolated crystals and the gradual development of these slips into fissures, followed by the rapid spread of these fissures along the cleavage planes of adjacent crystals, has been followed by the aid of the microscope both in the case of practically pure iron and in steel of various kinds. Consequently it may well be claimed that the mechanism of the mysterious failure of metals under fatigue is now known and well understood.

Within the limits of the present paper it has only been possible to outline briefly and in very general terms some of the more recent achievements of microscopic study of metals, and to point out here and there the obvious directions in which further discoveries are to be looked for. To attempt to prophecy the probable course of development of any branch of scientific investigation is always an extremely difficult task, but perhaps enough has been said to show that there is much yet to be learnt from the microscopic study of metals. Some of the results to be anticipated are of a directly and purely practical nature; in other

cases the lines of enquiry follow more scientific and theoretical directions; but even the most abstract of these questions bear in them —it may be confidently anticipated—the germs of practical applications of the widest importance.

DISCUSSION.

The CHAIRMAN (Dr. R. T. Glazebrook, F.R.S.), in opening the discussion, thought the author had clearly shown how he (Mr. Rosenhain) and those who had been working with him had been able to advance knowledge with regard to metals by the use of the microscope. Dealing first of all with the "anatomy" of metals, Mr. Rosenhain had described the means which might be employed to show their internal structure, thus enabling one to see how the physical properties were related to the structure. The question of the "diseases" to which metals were subject had also been dealt with, the author having indicated how the microscope brought out the defects of of composition. The slides shown had been made from various pieces of metal which had come under Mr. Rosenhain's notice, and by their investigation it had been possible to throw a good deal of light on many accidents that had occurred within the last few years. The effects produced by the improper treatment of metals had also been illustrated, some of the slides showing the weak and imperfect nature of the structure generally, and others the more perfectly formed structure, giving the real properties of the metal. Perhaps the most interesting part of the paper was that which dealt with the micro-physics of materials. The problem of the fatigue of iron had interested many people for a long time, and he thought it was not too much to say that the discovery by Professor Ewing and Mr. Rosenhain of the slip bands had gone very far to indicate how it was that the repeated action of small forces, especially if they were reversed in direction and acted alternately, undermined the strength of the metal, so that it actually gave way. The paper provided a considerable amount of food for thought, and had touched on many difficult points about which further information was desirable.

Mr. A. C. BROWN enquired if the author could give any information as to the effect on the molecules of a spring which was frequently displaced but apparently without friction. For instance, would a pendulum suspension spring really tire, and its tension be altered in the course of time?

Mr. H. F. GOLDING said that in the cooling of lead-zinc and aluminium-lead alloys there was a considerable alteration in the surface and central structures, a much finer grain being obtained on the surface than at the centre. In the case of steel in solid solution, the structure was retained by means of plunging, and it would be interesting to know if the same principle applied to the alloys to which he had referred. He had examined a few micro-structures, and had noticed a very marked difference; and he thought it would add to the interest of the paper if the author could give some information as to the relative strengths of the alloys under various conditions.

Mr. W. N. GARDNER enquired whether Mr. Rosenhain had done any work on gold, silver, and copper alloys, and if so what effect sudden chilling had on them.

Mr. JOHN E. SHIPLEY stated that a number of years ago Professor Ewing carried out an investigation on the magnetic properties of iron and steel, a fact which the author had not mentioned in his paper. At the present time steel manufacturers took great care in supplying electrical engineering firms with steel specially suitable for their needs. There were certain properties connected with iron and steel when subjected to alternate stresses, for instance, in alternating current dynamos, motors and transformers, of which, he thought, some explanation might be obtained by the microscopic method. It would be of interest to know whether an investigation had been made into such a property as hysteresis loss, or the ageing of transformer iron.

Lieut.-Col. ALLAN CUNNINGHAM enquired whether the author had microscopically examined specimens of similar kinds of iron and steel, some of which had been magnetised and others not; and i so, what difference was apparent.

Mr. SYDNEY W. SMITH said that in dealing with the question of surface tension the author showed some beautiful photographs, one of which, taken by Mr. Beilby, showed a slight analogy between the structure of the eutectic and a carbon film. He thought it would be useful if Mr. Rosenhain explained a little more in detail the nature of that film.

Mr. ROSENHAIN, in reply to the question as to the effect of vibration on a spring, said that so long as the deformation of any piece of metal remained within the elastic limit of the material no microscopic effect was produced. In a steel spring, the question depended upon whether the amount of deformation given to it was really within the elastic limit or not, and in the majority of springs it was quite within the elastic limit. There was at each deformation a small amount of permanent set. The same thing applied to the edge of a cutting tool, such as a razor blade or chisel. Such an edge, although made of the hardest steel, was so thin that it was capable of undergoing a small amount of permanent deformation every time it was used, and as a result it got into a state, not exactly

of disintegration, but into the state preceding disintegration, in which there were layers of mobile molecules, and while they were there it lost its springiness. It had been found that that state could be produced in a piece of ordinary steel. Those who were accustomed to dealing with steel in testing machines knew that if a piece of steel was overstrained beyond the elastic limit, the load being taken off and applied again to ascertain what effect on the elasticity had been produced, it would be found that the elasticity had practically disappeared for the time being. The steel was plastic to even small loads, due to the fact that the temporary mobile layers still existed, which were the result of the slip due to the previous straining. If the steel was boiled in water that semi-plasticity disappeared, and the cutting edge was restored to its elastic condition, which indicated that the layers of mobile molecules were caused to return to their crystalline allegiance by the action of the boiling water alone. In the case of a steel spring, it was very probable that here and there near the surface of the steel a little deformation took place each time, and if it was large enough it might lead to breakage; if not, it would lead to a gradual softening of the spring, which might be eliminated by warming it up. Lead-zinc alloys were very difficult to deal with, considerable difficulty being experienced, in the first place, in getting the two metals to alloy at all. In all, except the simplest systems of alloys, there were very considerable changes, in structure, strength, ductility, hardness, and every other quality, dependent upon the rate of cooling. There were some metals which would give very high ductility, and comparatively low tensile strength when cooled slowly, and which, when quenched above a certain temperature, would give two or three times the tensile strength but no ductility at all. When a discrepancy was met with in an ingot of an alloy between the apparent structure as shown by the external surface, and the structure indicated by its internal nature, it was quite certain that an alloy was being dealt with which had undergone a crystalline change between its first freezing and its final cooling down. The connection between the magnetic properties and the micro-structure was not a very obvious one. In transformer steel—steel with low hysteresis loss—there appeared to be a connection, *i.e.*, the larger the crystalline structure, generally speaking, the lower the hysteresis loss, but that was not by any means a quantitative connection nor a very certain one. There was certainly no change of structure visible on magnetising a piece of steel; a piece of steel whether magnetised or not magnetised looked the same under the microscope, the change of orientation of the molecules which was the result of the magnetisation being on too minute a scale to be detected by the microscope. With regard to the question asked on the subject of surface tension, the photographs he had shown were not Mr. Beilby's, but were prepared at the National Physical Laboratory. The carbon film was prepared by allowing a film of black to evaporate. The black was made by mixing finely-powdered carbon, animal charcoal, with turpentine; a drop was allowed to evaporate in a small drop on a piece of glass, and a photograph was then taken of it.

The CHAIRMAN, in proposing a hearty vote of thanks to Mr. Rosenhain for his instructive paper, said that the author, in replying to the question with regard to the behaviour of a spring, had referred to the elastic limit, but he had not stated what the elastic limit was. This was at present the subject of an important series of investigations at the National Physical Laboratory, and he was inclined to think a paper he had in his possession would answer some of the questions put by the first speaker in a manner satisfactory to all interested in progress. The author, in his reply, had referred to one very simple fact which had been known for many generations, viz., that it was a good thing to put a razor in hot water to renew its edge. The paper had demonstrated in many ways how microscopical investigations were intimately connected with practical affairs in life. The connection between the magnetic and electrical properties of materials such as iron had been the subject of many investigations and a number of researches had already been published. Others were in progress, and it was hoped in time by the aid of the microscope, and the application of delicate electrical and magnetic measurements, to answer some of the interesting questions which had been raised during the evening.

The resolution of thanks having been carried unanimously, the meeting terminated.

THE FRENCH WOOLLEN INDUSTRY.

France is one of the great wool manufacturing countries, but while the English great wool manufacturing industry is steadily increasing, the United States and Germany rapidly forging ahead, and Italy beginning to struggle for a place among the leaders, France is lagging behind, and the industry as a whole is stationary. This is due both to home and foreign causes. At home the French population is at a standstill and besides the people are of a saving turn of mind, so that the increasing wealth of the masses is not productive of any great increase in consumption. The fact that both coal and textile machinery is largely imported makes the first cost and also the working cost of the mills higher than those of their neighbours, such as Belgium and Italy. Legal restrictions also are numerous, and in at least Belgium, Italy, and Germany, longer hours are permissible. At the present time the French manufacturers of wool and worsted ship more than half of their exports to England alone, and of their main export in this line, clothing stuffs, over three-fourths are sent to the United

Kingdom. The American Consul at Roubaix says, that what Bradford is in England, Philadelphia in the United States, Verviers in Belgium, Brunn in Austria, Lodz in Russia, and Biella in Italy, such is Roubaix in France. Bradford, Verviers, and Roubaix, or rather Roubaix - Tourcoing, are more especially similar, as the industry in the other countries is more scattered. Roubaix and its twin town Tourcoing are in the department of the Nord, in north-eastern France near Belgium, and this department embraces over half of the spindles and looms, and nearly all the combs working on wool in France. The industry belongs to the north-eastern section of the country—old French Flanders, Picardy and Normandy—of which the modern departments are called Nord, Somme, Ardennes, Marne, Aisne, Oise, Seine-Inférieure and Eure. Next to Roubaix-Tourcoing the most important towns are Rheims, Fourmies, Cateau and Elboeuf. Vienne, on the Rhone, is the centre of the manufacture of what is euphemistically called in France "Renaissance" cloth, but which has sometimes been called shoddy, though also occasionally disguised as "merino," &c. The Department of the Tarn, a wool manufacturing centre in south-western France, owes its importance to its fellmongering industry. Sheep skins or "fells" are imported from abroad, mainly from South America, and are relieved of their wool by careful soaking and heating, without the use of chemicals. Part of these skin wools is used in France and part shipped to England and other countries. The hand-loom industry centres round Cambrai and St. Quentin; and although declining of recent years, it is still a somewhat important industry, and some of the most artistic French work is made on these looms. Formerly Amiens was the centre of this industry, and the Picardy hand weavers had an inherited skill that enabled them to compete with power looms on all lines where skill and address were needed to meet the sudden demands of fashion. Even in the machine industry, however, there are now periods towards the end of each season when the mill workers are idle, and though the hand-loom weavers eked out their living by farm work, these periods of idleness, which are more severely felt by their branch of work than by the regular mills, have, together with the demand for "tailor made" clothes among women, driven them to gain their living in a steadier occupation, so that there is now little or no home weaving left in that neighbourhood. In the Cambrai district there are still villages of three to four hundred home weavers. The business part is carried on through middlemen, who buy the yarn from exporters, with whom they agree as to the kind of goods to be made, and fix the price, and then make their own terms with the home workers. In the Cambrai-St. Quentin district, one thing that has cut down the number of such home weavers of late, is the fact that they are established in a district that is dominated by the progressive lace industry. The *entrepreneur de découpage*, or clipping contractor, makes the house-to-house round through these villages, offering work at clipping the floats and cutting apart the lace strips, as made on the machines of Caudry and Cambrai; and though the remuneration is small, the work is easier and less absorbing than that of hand weaving, besides being much steadier, so that in many cases the shuttle is laid aside for the scissors. There appear to be no accurate figures as to the machines and operatives employed in the French wool-working industries. A parliamentary committee, which enquired into the trade in 1904, estimated that there were 2,000,000 worsted spindles, 390,000 woollen spindles, and 35,000 looms. The French census for 1901 shows 161,355 active workers in the "Industrie Lainière." In the latter case at least the figures appear to be too small, as several subordinate branches of the industry are included under "textile industries not specified." It is clear, however, that the worsted branch of the business is much larger than the woollen, and also that the combing branch of the industry is proportionately larger than in the case of most other wool manufacturing countries. The combing mills not only supply their own spinners, but the export of "tops" is a large industry in itself. The French wool-working industry, being concentrated in the district round Roubaix-Turcoing, is just on the edge of the Belgian border. It is very close to Tournai, Mouscron, and other Belgian towns interested in wool-working, and there seems a strong tendency for part of the industry gradually to move across the border. Land, coal, machinery, and building materials are all cheaper in Belgium, and as living is also cheaper, wages are lower. Taxes are lower and legal restrictions are fewer. Wages in Roubaix-Turcoing itself would be much higher were it not for the large number of Belgians working in the mills there who have their homes just over the border in Belgium. Part of the machinery used in the French wool-working industries is made in France, at Roubaix, Lille, Belfort, &c., although the bulk is imported. The old centre of the French manufacture of textile machinery was at Mülhausen, in Alsace, and since its loss no new centre has taken its place. The United Kingdom largely supplies the spinning machinery and looms, Mülhausen the looms and combs; Switzerland exports looms, and there is also some machinery imported from Belgium and other countries. The Roubaix manufacturers have yearly to face keener competition from the comparatively young wool-working industries of Germany and Italy. They say that though Germany still buys large quantities of tops, their takings are decreasing, and at the same time they are beginning to reach out for the French markets for tops in Poland, Moravia, and other places. They already say that Italy's competition is increasing fast, especially in the Levant, where the cheap Italian cloths and stuffs, well made and skilfully dyed, are displacing similar French goods, which is due to the fact that the Italian workman is similar in his artistic tendencies to the

Frenchman, and can live and work more cheaply. In the beginning of 1904, the French wool-working industry was in a bad condition. It partly recovered in 1904, had a good year in 1905, and in 1906 had one of the most prosperous seasons of its history. This continued until about the middle of 1907; since then it has been much depressed. The spinning and weaving mills do not ordinarily run at night, while the combing mills do. The combing mills, however, are the most subject to fluctuations, and frequently the end of the season sees the stoppage of all night work, and in recent years the tendency has been to shut down from the latter part of August to the latter part of November. Dunkirk is the port for Roubaix-Turcoing, as is Antwerp for Verviers and the Rhine, and Hamburg for North Germany. These are the three wool ports of the Continent. The wool imported at Dunkirk is nearly all in the greasy state. The manufacturers prefer it in this style, for though the freight cost is greater, the fibres are kept supple on their long journey and do not mat together, as would be the case with close-packed washed wool. Most of the wool, whether from Australia, La Plata, or elsewhere is "cross-bred," that is, it is clipped from sheep that are a cross of the old Spanish merino breed, with its short but fine fleece, and the English Lincoln or Leicester, with its longer, coarser fleece. The Rheims mills, which have devoted themselves more to the use of the fine merino wool are decreasing, because they have not so readily adapted themselves to the use of the cheaper and more popular cross bred wool, as have the Roubaix mills. In olden times, Sedan was the centre of the woollen industry and Rheims of the worsted. The former has almost dropped out of the industry, and Rheims is steadily losing ground, as are nearly all other French wool-manufacturing towns except those in the neighbourhood of Roubaix-Turcoing. There are some 20,000,000 sheep in France, the best of the flocks being in the north-east departments, producing about 95,000,000 pounds of wool annually, that is to say, wool in the grease. As these fleeces are estimated to give a yield of 39 per cent. of washed wool, this amount produces some 37,000,000 pounds of pure wool. In 1907 the French woollen industry used some 155 million pounds of pure wool. With regard to the exports of French woollen manufactures, Great Britain takes three-fourths of the pure woollen stuffs for clothing, and the remainder goes mostly to Belgium, Japan, and the United States. Of the cashmere and other cloths exported, Great Britain and the United States each take a sixth, and the remainder goes to Italy, Belgium, Spain, Switzerland, Algeria, Chile, Argentina, Germany, Brazil, and Turkey. The great bulk of the yarn exported is the combed yarn, and it is bought by Great Britain, Belgium, and Germany. One-half of the knitted goods go to Great Britain and the remainder to Belgium, Switzerland, and Italy. The blankets go to Egypt, China, Belgium, and Algeria; the carpets to Great Britain, United States, and Belgium; the pure wool stuffs for furniture to Great Britain and Italy, and the *passementerie* mainly to Great Britain, with some to Spain, United States, and Switzerland. Fezzes go to Senegal and West Africa; shawls to Colombia and Mexico, and mixed goods to Great Britain, Italy, and Belgium. French possessions and colonies form a very important market for the French cotton manufacturer, as they take a fourth to a fifth of his total exports, but they are of slight interest to the French wool manufacturer, as their takings in this line account for but 3 per cent. of his total sales abroad. The total value of the exports of woollen and worsted tissues exported from France in 1907 amounted to £1,835,000.

WHEAT ELEVATORS FOR INDIA.

Mr. Frederick Noël-Paton, Director-General of Commercial Intelligence, has published some interesting "Notes"* on the question of wheat elevators for India. The deductions which he has tentatively drawn, he explains, "are not set down as representing opinions held by the Government of India, but merely as embodying the conclusions that appear to the author to issue from a study of the facts stated."

The importance of the wheat crop of India may be gauged from the fact that in the seven years ending 1906-7 the area under this cereal has averaged about 26,000,000 acres, while the annual output has been estimated at 7,900,000 tons. The exports during the last five years have averaged over 1,200,000 tons per annum. In 1904 the United Kingdom imported more wheat from India than from any other single source; and in 1907 it took 771,525 tons, or nearly 88 per cent. out of a total of 880,459 tons exported.

It is a winter crop, being grown chiefly in the north-western parts of India, reaped in what in Europe are called the spring months of the year, and coming on the Indian market from April onward. Towards the end of June the rains begin which inflict serious damage on any wheat not properly protected. This damage is caused not only by direct wetting, but by heat and mould, and by weevils whose activity is increased by moisture. The havoc wrought by these insects is immense. Mr. Noël-Paton refers to some investigations which showed "that wheat uncontaminated with weevil before the experiment lost 26 per cent. of its weight in three months after the first introduction of the insects, while 65 per cent. of the kernels were at the end of that time found to be weevilled. The rate of multiplication was enormous—so much so that, in order to limit it and to keep tale of it at all, it was thought necessary to remove large numbers of weevils from the wheat on two occasions. If, in

* "Wheat Elevators for India." By Frederick Noël-Paton. Calcutta: Superintendent Government Printing India. 1s. Mr. Noël-Paton uses the term "elevator" in its American sense, which includes the means of storage, &c.

spite of this measure, it was found at the end of three months that the weevils had multiplied their numbers sixty times, it is clear that without such interference the increase would have been much more rapid."

Great loss is also inflicted on the holders of grain stock in India by human thieves and by rats—"the extent of their depredations greatly exceeds anything that would readily be believed by persons not acquainted with India and the conditions of storage there prevailing."

For these reasons the shippers are naturally anxious to get all export wheat out of the country as soon as possible. Thus a very great strain is suddenly thrown upon the railways, and the clamour for increased facilities of transport has been loud. Mr. Noël-Paton is of opinion that if by the provision of means of storage corn could be garnered under conditions which assured immunity from damage from the causes enumerated above, the holders of wheat could confidently retain their produce till the worst of the rains were past. The advantage resulting from this would be twofold: in the first place, Indian merchants would no longer be compelled to throw all their wheat on the world's markets at the same time, while the railways would be enabled to earn a more constant income on such rolling-stock and other equipment as they supply.

Mr. Noël-Paton discusses at some length the various classes of private, public, line, and farmers' elevators (which are all to be found in America), and the financial functions which they perform. He has also something to say on the important question whether it would be practicable and expedient to institute a system of official grading and certification, but, he adds, it is very doubtful whether the moral atmosphere of India offers a matrix favourable to the production of a body of competent and reliable inspectors. It is impossible, within the limits of a short article, to explain all the considerations into which he enters; but the upshot of his "Note" is that his investigation "seems to point more definitely to a preference for private as against public elevators" as a means of improving the condition of the wheat trade of India.

THE PAINTING OF STEEL.

In the course of an exhaustive paper on "Paint, and its Application to Structural Steel," recently read before the Paint and Varnish Society, Mr. Gaston Despierres gave some valuable information on a subject which is from day to day growing in importance. The enormous increase of late in the use of steel in buildings and engineering constructions, he said, "demands increased vigilance and attention to its maintenance and present condition wherever it has been placed, as, either from corrosion, fatigue, vibration, or general deterioration, the metal may become so impaired as to be unfit to do that for which it was designed; and unless it is properly protected by coatings of paint at various periods, those entrusted with its care will assume the enormous responsibility for further catastrophes entailing great expense, and, worse still, shocking loss of life.

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"The first, or priming coat, upon a surface of steel in a fit condition to receive paint, is of the greatest importance, in view of the circumstances that the union of the paint and the substratum depends entirely upon the adhesion of this coating, and the first problem to be solved in the painting of steel is necessarily—not which paint sticks best on another coat of paint, but which paint adheres most firmly to iron.

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"For a long period, red lead alone was employed for this purpose, and even now still enjoys a reputation not altogether undeserved, and, when in competent hands, has given very fair results. However, personally, I do not admit that red lead is the best and ideal pigment for priming, as it must be borne in mind that of all pigments it requires the smallest proportion of oil or varnish in order to form a distributable and well-covering paint; and it must be noted that the protection afforded by the pigment is largely dependent upon the property it has of absorbing and retaining oil.

"Also, on account of its great specific gravity—(9·19)—the proper mechanical mixture of red lead with oil is almost impossible, as settling and setting take place very rapidly; hence the general practice of mixing in the kettle before the application.

"After many experiments spread over years, I have come to the conclusion that the most perfect priming coat is obtained by the use of orange lead, a pigment of lower specific gravity—(6·85)—and of finer texture, which, when mixed in certain proportions with an inert pigment having a great oil-absorption, produces a paint which can be properly ground and mixed for use, having, by reason of its fineness, great adhesive power, and being capable, owing to the presence of the inert pigment, of lessening the oxidizing action going on between the oil and the lead oxide, thus shortening the life of the linoxyn formed.

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"It is known that the durability of any oil paint depends largely upon the number of particles of pigment, the better protection to the binder and to the metal underneath—the evil of thinning paints too much is therefore obvious. A layer of air exists on all surfaces—hence the importance of rubbing out the paint thoroughly, as otherwise, bubbles of air may be discovered which, coming through the paint, render the coating porous.

"As to the spraying of paint upon structural steel by means of air compressors, I am of opinion that it conveys air and moisture to the metal, and helps the formation of rust; besides, its many disadvantages have led to its abandonment by nearly everyone who has tried it.

"The adherence of paint would no doubt greatly increase if it were possible to heat the surface by artificial heat; but when painting is done on the job, it is impracticable to warm and dry the metal artificially; however, it is a good plan to apply the paint heated to a temperature of 100 to 120 degrees Fahrenheit, especially when the temperature of the air is below 55 degrees. This is easily attained by placing the cans of paint in pails of hot water.

"It is important always to note the atmospheric conditions when painting is being done—a temperature of 70 degrees F., and an atmosphere free from moisture, favour the right kind of drying; in fact the humidity is more harmful than a low temperature. Nothing retards drying more than dampness and darkness.

"To aid in the inspection of new work, a shop-coating of linseed oil is often specified. This does, in a measure, protect the iron from rust; but a very uneven film of dried oil is often obtained by this method of treatment. Oil applied to a vertical surface runs off until the layer reaches a certain thickness. When the current meets with an obstruction, it piles up into a thick and uneven coating. The thick parts of the layer may require months to harden into a substance firm enough to be fit to paint over."

THE PORT OF LONDON.

Members of the Authority.

In accordance with the provisions of the Port of London Act, 1908, the Board of Trade have taken the necessary steps for constituting the Port of London Authority. The members of the Authority are as follows:—Chairman: Sir Hudson Ewbanke Kearly, Bart., M.P. Appointed Members:—By the Admiralty: Rear-Admiral A. Mostyn Field, R.N., F.R.S. By the Board of Trade: Mr. J. G. Broodbank, Mr. H. Gosling. By the London County Council:—Members of the Council: Sir J. McDougall, Mr. W. H. Pannell. Not Members of the Council: Mr. James Anderson, Mr. John Duthie. By the Corporation of the City of London:—Member of the Corporation: Mr. J. W. Domoney. Not a member of the Corporation: The Lord Ritchie of Dundee. By the Trinity House: Captain H. A. Blake. Elected Members (nominated by the Board of Trade): Mr. I. Hamilton Benn, Mr. C. E. Brightman, Mr. Charles Charleton, Sir Edward Cornwall, M.P., Mr. G. T. Crosfield, Sir. C. Furness, M.P., Mr. C. F. Leach, Mr. L. A. Martin, Mr. H. T. Moore, Mr. Owen C. Philipps, M.P., Mr. E. G. Saltmarsh, Mr. Hugh C. Smith, Mr. C. T. Torrey, Sir Montagu Turner, Mr. F. Shadforth Watts, Mr. W. Weddel, Mr. Richard White, Mr. W. Varco Williams. Additional Member: Mr. S. E. Bates.

ARTS AND CRAFTS.

Design—The early spring is not a time of year when there is very much craft work to be seen. Producers of many kinds, especially the producers of small things (jewellery and such like) have had their stocks depleted by the demands of Christmas, and those people who have larger work on hand are holding it back for the various exhibitions later in the year. On the other hand, it is the season *par excellence* for seeing what is being done in a more commercial way. The shops are all trying to show their newest and best, with a view to attracting the attention of the passing householder. For it is in the early spring that we look for the new wallpaper and cretonne patterns, the latest carpet designs and styles of furniture—in fact for all things new in the way of household decoration, even to the latest fashions in white window curtains.

As regards pattern design generally, there has been the same steady move forwards in the matter of style that has been going on for the last few years. We have run through the periods of the French Louis and Queen Anne, of the Brothers Adam and the later Georges, and have arrived at reproducing the patterns which were in vogue before the "great exhibition" of 1851. The great mass of the wallpapers and cretonnes being shown this year are naturalistic floral designs with a distinctly early Victorian flavour. The fact that amongst these there appears every now and again a design or two palpably reminiscent of the work of William Morris (though some of these patterns, at any rate, have been about for some years) makes one almost wonder whether we have got to the point when Morris's work may be considered old enough to bear repetition as an "historic style." If so, since it is certainly too soon to begin reproducing *l'art nouveau*, we have clearly reached the end of our path, and it becomes a question of considerable interest where the next cycle will begin. Shall we go back to the stiff archaism of Egypt and Assyria, to the grace of the classic forms, or to the vigour of Gothic ornament? Apparently no one knows. We may take consolation though from the thought that whatever it is, it will inevitably be better than the present fashion. That when once this has grown stale, there will be a return to some historic style seems to be at least indicated by the number of reproductions of old silks, &c., that are being brought out. For the time being, of course, this is bad for the modern designer, who gets no chance of showing what he can do. If, however, it points to a desire for patterns which are really designed, and not just thrown upon the paper (and some at least of the manufacturers say that it does) it may be a hopeful sign.

Wallpapers.—So far at any rate as wallpapers are concerned, the spot (or as some people irreverently called it "the pimple") pattern which has so long reigned supreme seems to have entirely disappeared. One sees, it is true, now and again,

designs which appear at first sight to be sprig patterns; but on closer inspection it turns out almost without exception that they are either stripe patterns broken by sprigs at intervals, or lattices in whose openings flowers are from time to time spotted about. The stripe is still in vogue and is sometimes so used that each side of the room is looked upon as a panel bordered by ribbons which are tied in knots or bows at the corners. The fashion so prevalent a short time ago of putting an elaborate frieze at the top of a plain filling has been somewhat modified, and the points of the frieze are nowadays emphasised by a striped filling-paper which carries them down the wall. Still, though there are plenty of stripe patterns yet to be seen, it is the lattice which is most obviously to the front, and a very large proportion of the new patterns consists of lattices of one kind and another, from the simplest kind of interlacing ogee to the most elaborate trellis almost hidden by masses of naturalistic fruit or foliage. Those patterns which are neither stripes nor lattices are for the most part either very open in character or frankly based upon old brocades or damasks. The device of breaking the ground in such a way as to make the paper look like any other material than itself is still being employed, though not, perhaps, quite so much as some time back. The furthest point to which imitation can go seems to have been reached when flat papers are trickily printed and arranged to look like tinted plaster relief.

The practice of producing the same designs in wallpaper and cretonne for the purpose of bedroom decoration is again coming to the fore. There is doubtless something rather attractive, especially to those people (and they are many) who are rather afraid of contrasts, in the idea of having one's bed hangings, curtain, and wallpaper all to match. The danger is, however—and it is one of which the buyer is seldom aware—that before the decorations have been in place many months they will be anything but identical, or even harmonious in colour. Wallpapers are printed in distemper colour; cretonnes are dyed, and the effect of the action of the light on what is apparently the same colour in distemper and in dye may be, and often is, totally different. And thereby hangs a tale. The reasonable thing to do under the circumstances would be to hang the walls also with cretonne.

Cretonnes.—Cretonnes follow, on the whole, the same lines as wallpapers. They seem, however, for the moment at least, to be still more largely given over to naturalistic floral patterns of an early Victorian type. The place of the reproductions of damask patterns so common in wallpapers is, however, taken by adaptations of so-called "Early English" crewel patterns and of designs borrowed from Indo-Portuguese needlework—whilst a certain number of chintzes are to be seen which are clearly based on old Oriental prints. The lattice and trellis patterns, though not perhaps so general as in wallpaper, are still abundant, but stripes are by no means so much in evidence as they were a year or so back, whilst the little sprig diaper patterns, until recently so universal, seem to have disappeared entirely. Imitation of other fabrics is not quite so easy in printed cotton as in printed paper—but a good many of the crewel designs have, at a distance, a very fair resemblance to needlework—and there is a practice of printing patterns with jagged edges in such a way, as to look, at first sight at any rate, as if they were woven.

Carpets and Furniture.—The open interlacing ogee pattern is ubiquitous, and is not only fashionable in wallpapers and hangings, but the *dernier cri* in carpet design—where it seems to have somewhat ousted the Louis Quinze carpets with their plain background, and carefully unsymmetrical central feature. Little spot or sprig patterns are still to be seen, but they are just now relegated for the most part to "art squares" and stair carpets.

The trade furniture to be seen in the shops is, for the moment, duller than might have been expected. The craze for modernity which, wild and unsatisfactory as it was in many ways, had at least some life in it, seems to have passed away almost completely. Furniture, with the exception of simple bedroom suites and chairs, &c., suitable for the halls of country bungalows, is almost always on lines which make it difficult to believe that furniture making ever got shaken in the smallest degree out of its old ruts. The fashion for heavily painted satinwood has passed, and there is less of the regulation shell to be seen on the tops of tables, but there is very little that might not have been designed at almost any period but our own. As regards the simple bedroom furniture which shows some trace of modern influence, it is at times somewhat clumsy and heavy in effect, and is, moreover, occasionally spoiled by having legs which, in appearance at least, are quite inadequate to its support; but for all that there is a certain simplicity in its lines and a dignity in its masses which attracts ones attention by no means unpleasantly. It is a pity that in some of the cheaper kinds of furniture the practice of inlaying in different coloured woods has been rather done to death. There is no prettier decoration for wardrobes and cupboards than this wood inlay tastefully used, but taste is absolutely essential, and when it is absent the results are by no means satistactory.

CORRESPONDENCE.

THE BUDDHIST AND HINDU ARCHITECTURE OF INDIA.

With reference to my paper on "The Buddhist and Hindu Architecture of India," and the subsequent discussion, published in the *Journal* of March 5, I should like to add a few remarks in order

to clear up various points which might seem to require further explanation.

In the first place, having only one hour at my disposal to deal with a very extensive subject, I aimed at describing only actually existing monuments, and purposely refrained from going into questions of prehistoric and conjectural origins. Had I entered upon that domain I should certainly have stated my belief, which I have already expressed elsewhere, that the three types of Buddhist architecture, the Stupa, the Chaitya, and the Vihara, were only Buddhist adaptations of previously existing types of indigenous Indian buildings, the latter two types having been wooden structures. Having for many years studied Indian institutions in ancient Sanskrit literature at first hand, I am certainly not one of those who believe that the early Aryan invaders founded all the Hindu religion, architecture and arts. On the contrary, I have pointed out in my "Vedic Mythology," how, for instance, phallus-worship and snake worship must have been borrowed by the Aryans from the aborigines. As regards the existence of temples, which, in any case, must have been of wood and very primitive, in pre-Buddhistic times, among the aborigines, it is a matter of pure conjecture. On the other hand, I cannot but believe that idols of a fetishistic order, though not of a sculptural anthropomorphic form, existed among them. As to the conjectural origin of ancient Buddhistic temple architecture in India from the type of the pagodas of the hills I certainly share Colonel Hendley's doubts. We run the risk here of explaining the origin of the ancient Chaityas from structures of the present day which are not improbably the Nepalese descendants of those Chaityas themselves. It is not clear to me what Sir G. Watt means by speaking of the religion of the Atharva Veda as identical with Brahmanism. At any rate, it can hardly be said that in that Veda the old pantheon had been extended by the admission of earthly gods, spirits, and demons. These were equal y well-known to the Rigveda, as I have shown in my "Vedic Mythology," and elsewhere. To me at least it seems an improbable conjecture that, because Jains as well as Buddhists built Stupas, relic worship goes back to an early and common faith. In the first place, we do not know how much early Jainism was influenced by Buddhism. Again, these two religions were the first in India to originate from a personal founder. Relic worship would, therefore, naturally have first started in connection with them or one of them. I do not understand what can be meant by saying that the *dharma*, or "book of the law," and the *sangha*, the "tree (?) or congregation" appear as symbols on the monuments. The *chakra*, or wheel, certainly appears as a symbol of the law, and the Bo-tree is, of course, very often represented in the early Buddhist sculptures. Again, the trident or *trisul*, which often appears on the Buddhist monuments, is well known to be the distinctive emblem of the god Siva also. It is, therefore, not clear what is meant by saying "that by certain Hindus (it) is supposed to belong to Vishnu." I have shown in my lecture at Oxford that some of the symbols occurring on Buddhist monuments can be traced as far back as the Rigveda. I am not one of those who share the opinion that the art displayed in the Karle Chaitya, with its elaborately carved Persian pillars, is "very rudimentary," a term which I apply to the conjectural pre-Budhistic art of five centuries earlier.

My object in dwelling on the evolution of the Chinese pagoda was to demonstrate the connection between the funeral mound and the porcelain tower at Nankin by illustrating every-step in the development. I fear I may not have done so in a convincing manner. Fergusson saw the connection, as I said in my paper, and distinctly states it in the passage quoted by Sir G. Watt. But he nowhere demonstrates the connection in any of his works, all of which are known to me, as far as I can discover.

I gather that the demonstration of how the Indo-Aryan tower was evolved from the Stupa was not convincing either. It would, however, have been useful to indicate what the weak points in the argument are. I have more evidence on the subject which there was not time enough to exhibit at my lecture. But I intend to adduce it elsewhere. Fergusson, as I have shown in my paper, states that the Indo-Aryan tower cannot be explained from any known architectural form.

A. A. Macdonell.

DEW-PONDS.

Mr. Hubbard's interesting paper deals fully with the physical causes by which dew-ponds operate. One other aspect is that of their use by primitive man as a means of water supply. In a little book of mine, recently published ("Prehistoric Man on the Highlands of East Surrey") this side of the question is discussed. In some of the remote villages, lying in the hollows of the Wilts and Berks Downs, the folk of to-day have to imitate prehistoric practice. In times of drought they send to the dew-ponds, high on the hills, to fetch water for the villages, situate perhaps hundreds of feet below. The problem of water supply in miniature, by means of dew-ponds, is fascinating, and I have patented methods for effecting this purpose. There are isolated mansions and scattered hamlets in the chalk country, where a dearth of water is one of the banes of existence. The drawbacks of a deficiency of the first requisite to the health and well-being of a community are patent. There are villages where, after a spell of drought, the poor folk have to buy water by the bucketful and carry it long distances. If the town-dweller has his water supply cut off for a couple of hours, he considers himself hardly used. These down-landers patiently endure a chronic condition of water famine, and, outside their valleys, little is heard of their trouble. I am convinced that

the unfailing supply of pure water, latent in the "brave o'erhanging firmament," can be successfully tapped, and the problem thus solved.

The villager would gladly dispense with more showy privileges if he were only relieved from the phantom of intermittent drought. This is not a small matter. It is one to which County Councils, and landowners, and legislators might well devote their energies. The expense of laying on a water supply from "this most excellent canopy, the air," is trivial, as compared with that of well-sinking and pumping. It is strange that the more obvious and easy expedient should be neglected, especially in a time when we have (to quote Mr. Punch's omnibus driver) "to put up with so many improvements."

In the "Geographical Journal" for September, 1908, and February, 1909, occur three papers on "Swallow-holes." These are shallow, superficial depressions, dotted over the districts described. It is argued that in some localities they have been formed entirely by downward solution. They resemble pits or craters scattered over the surfaces of the areas detailed. In other instances artesian conditions and upward hydrostatic action of water under pressure are regarded as predisposing causes, in conjunction with solution. Colonel Pitt, in describing those near Alton in Hampshire, suggests that immature swallow-holes may have been, in some instances, utilised in the formation of dew-ponds, these natural basins having been puddled.

A. E. Casey, M.Inst.C.E., F.G.S.

The interesting paper read last Wednesday, and reported in the current *Journal*, will, no doubt—as the Chairman (Sir Edwin Durning-Lawrence) remarked, be widely read and quoted from, and I therefore have pleasure in congratulating my professional *confrère* thereon. I, however, suggest to Mr. Hubbard that there is probably another reason why a chalk bottom is the most successful in the formation of dew-ponds, and that is the great—in fact, "greedy" —affinity, chalk (or lime) has for moisture, thus ensuring that the layer of straw, containing the "still air," is kept dry.

It is interesting to refer to Gilbert White's "Natural History of Selborne"—letter lxxi.—written 133 years ago, in which dew-ponds are mentioned, and in which, incidentally, some pregnant remarks occur touching the fringe of afforestation which are signally applicable to the important question of water supply to districts having a deficient rainfall.

John Leeming.

OBITUARY.

Frederick Goulding.—Mr. Frederick Goulding, who died at his residence at Shepherd's Bush on the 5th inst., was well known in the artistic world as a printer of etched and engraved plates. At one time he did a great deal of work for Whistler, but it was Sir Seymour Haden who gave him his first opportunity for cultivating his skill. His work was often exhibited at the Royal Society of Painter-Etchers and Engravers, where, indeed, from one point of view, it sometimes practically constituted a "one-man show." Mr. Goulding was elected a member of the Royal Society of Arts in 1897, and he occasionally took part in discussions upon subjects closely connected with his art.

QUESTIONS AND ANSWERS.

NOTICES TO CORRESPONDENTS.

On all communications must be written the name and address of the sender, not necessarily for publication, but as a guarantee of good faith.

Each question or reply should be written on a separate sheet of paper, and should bear such signature of the writer and such address as he wishes to appear.

Questions which can be answered from the usual books of reference, will not be printed.

QUESTIONS.

Sheep in Australia.—When were sheep introduced into Australia, and by whom?—Colonial.

Weevils.—What is the best method of getting rid of weevils in grain?—Miller.

German Whitaker.—Is there any work published which gives for Germany information similar to that given for this country by Whitaker's Almanack? —Enquirer.

Fire-Walking.—Can anyone explain the secret of the Fire-Walk? I understand it is principally practised in Fiji, but that it has also been witnessed in such a country as Japan. Is this so?—Ignis.

ANSWERS.

Anticipation of the Aeroplane.—The painter to whom "Icarus" refers as having anticipated mechanical flight was Leonardo da Vinci. This wonderful man, who was as good an engineer as he was a painter, has left a number of drawings referring to mechanical flight which are well worth the attention of aeronauts to-day. Among other drawings he gives one of a parachute which is so well designed that it is free from the dangerous oscillation that has cost subsequent inventors their lives. His description which accompanies the design is quite clear, and the dimensions given show that he must have made practical experiments on the resistance of the air. He says:— "Se un homo ha un padiglione, intasato, che sia 12

braccia per faccia e alto 12, potrà gittarsi d'ogni grande altezza senza danno de sè." An excellent collotype reproduction of some of these aeronautical drawings, accompanied by a French translation of the descriptions, was published in 1893 by E. Rouveyre, Paris. The chief of these manuscripts are in the libraries of Paris, Milan, and Windsor; but "Icarus" will have to spend many a weary hour in preparing himself to read them, for most of them are written from right to left, and there are many abbreviations and signs difficult to understand. Leonardo da Vinci appears to have anticipated balloons also. Vasari describes some of his experiments in the following terms:—"Leonardo, therefore, having composed a kind of paste from wax, made of this, while it was still in its half-liquid state, certain figures of animals, entirely hollow and exceedingly slight in texture, which he then filled with air. When he blew into these figures he could make them fly through the air, but when the air within had escaped from them they fell to the earth." There can be little doubt that the figures fell because of the cooling of the air within them, and not because of its escape, as Vasari thought. It is more than probable that the figures which looked like wax were in reality gold-beater's skin, a material that Leonardo was in the habit of inflating, for in another place we read:—"He more than once caused the intestines of a sheep to be cleansed and scraped until they were brought into such a state of tenuity that they could be held within the hollow of the hand. Having then placed in a neighbouring chamber a blacksmith's bellows, to which he had made fast one end of the intestines, he would blow into them until he caused them to fill the whole room."—WALTER F. REID.

GRAIN ELEVATOR.—I may say that the almost universal practice in this country and on the Continent of Europe is to restrict the term to the machine or apparatus employed for lifting the grain. In Canada and the United States of America the term is used to denote an entire grain store or granary. The actual grain-lifting appliance is also spoken of in America as a grain elevator, or simply as an elevator; or again as an elevator leg, or merely as a leg. The American use of the term "elevator" is not a happy one, because besides denoting a grain store, and a machine for lifting grain, it is the only word they have to designate what we call a passenger lift. The instances of the use of the term "grain elevator" in the American sense outside of America are traceable to American influence or origin. For example, the large granary at Manchester belonging to the Ship Canal Company, known as the grain elevator, was built by American engineers and has had an American engineer as manager from the commencement. Similar constructions of English origin, in use by grain merchants and grain users all over the United Kingdom, are spoken of as silos, grain silos, or silo granaries.—JAS. WHITAKER, Assoc.M.Inst.C.E.

SHEFFIELD PLATE.—Thomas Law and Co. were of the earliest to bring Sheffield Plate to perfection in manufacturing candlesticks, ink-stands, and larger articles in copper plate. Examples of their make may be seen in the Museum of the Sheffield School of Art, and I have pattern books showing a large variety of beautiful articles of their manufacture of great antiquity. Thomas Law was Master (1753) of the Ancient Cutlers' Company of Hallamshire, whose Charter dates from 1624.—W. H. LAW.

GENERAL NOTES.

FREE TRADE AND INDIA.—This is not the place to discuss the relative merits of Free Trade and Protection, but it is pointed out from Calcutta that if England discards Free Trade, a demand that may be difficult to resist will arise in India for the protection of its struggling native industries. This view finds expression in a "Survey of the Industries of Eastern Bengal and Assam," which has been carried out by Mr. G. N. Gupta, of the Indian Civil Service, and published as a Government report. The assumption underlies Mr. Gupta's report that it is the function of Government to be the pioneer of new industries, to guarantee interest on capital invested in certain industries, and to "render pecuniary advantage to firms or persons who are willing to engage in any profitable industry." He believes that the hand-loom industry can be restored to its former prosperity, and urges that power-looms should be developed, because "the increased production from power-looms will replace, not the products of Indian hand-looms, but the imported manufactures of foreign countries." It may be remembered that the Government of Madras have become pioneers in the aluminium and leather industries, while in the United Provinces it has been resolved that "the Government may properly make money grants for definite purposes to new enterprises."

SOURCES OF THE BRITISH WHEAT SUPPLY.—The proportion of the wheat requirements of the United Kingdom that comes from home cultivation and foreign supply is constantly varying; but Messrs. Montgomery, Jones and Co., of Liverpool, have just issued a circular which gives the aggregates and averages of the past five years. The United States still rank first with 23 per cent. of the wheat we use. British farmers at home contribute approximately 20½ per cent.; Argentina comes next with 20 per cent.; then India, 14½ per cent.; Russia, 14 per cent.; Canada, 11 per cent.; Australasia, 7½ per cent., and sundry countries 9 per cent. Taking as a basis the annual averages of these five years, the British Isles produced 6,760,000 quarters; the British possessions sent us 8,663,600 quarters; and foreign countries,

17,683,600 quarters, making together 33,107,300 quarters as the annual food and seed supply for our population, which averaged 43,888,000 during the period. Or to put it in another way, the United Kingdom supplied 20½ per cent., British possessions 26 per cent., and foreign countries 53½ per cent. of the United Kingdom's supplies of wheat during the past five years.

ROYAL COMMISSION ON THE WEST INDIAN SUGAR TRADE.—Speaking recently at a dinner of the West Indian Committee and the West India Club, Lord Crewe stated that for some time past the Government had been engaged in what diplomatists called an exchange of views with Canada on the subject of the West Indian sugar trade, and in the result, on the suggestion of the Canadian Government, it was intended to appoint a small Royal Commission to inquire into the subject. Two Canadian gentlemen of distinction would be appointed, with two English representatives, and the fifth member to represent the interests of the West Indies would be Sir Daniel Morris. The Commission would be invited to inquire into the commercial relations between Canada and the West Indies, including the questions of transport and communication. It was hoped that the Commission would have the further advantage of the assistance of Mr. R. H. Macarthy, and he trusted the inquiry would begin during the coming summer. The more closely the Colonies found it possible to act in concert the stronger would be their position.

BRANDY.—Some interesting evidence with regard to brandy was recently given by M. E. Martell, of Messrs. Martell and Co., Cognac, before the Royal Commission on the Manufacture of Whisky and other Potable Spirits. Brandy, he stated, was only the equivalent for *eau-de-vie*, which, according to the French law, could be applied to different mixtures of spirit. The real designation of the product that the new French regulations were framed to protect was cognac, or Cognac brandy, and this should be a spirit distilled from Charente wine by the ordinary process. They did not think there was any necessity for brandy to be kept in bond in England, for, as a general rule, firms shipping Cognac brandy in bottle shipped a quality older than any limit that would be likely to be imposed, and the public would suffer from the additional expense incurred. Any guarantee suggested would depend in a great measure on the authenticity accorded by the Commission to the guarantees that could be given by the French Government. Speaking for themselves, they had conformed to the spirit of the new law for years past. Brandy, taking the word in a general sense, should be a spirit distilled from the wine produced from grapes. Cognac brandy should be a spirit distilled from grape wine produced in the two departments of the Charente. As a rule, in the Cognac district, the stills employed were pot stills, although in some cases a still *au premier jet* was employed, but this must in no way be confounded with what was termed in England a patent still, as it was simply a kind of pot still, completing the fabrication more quickly than the ordinary pot still, and thus giving economy in the way of fuel, &c. As to the question of *aquits*, they suggested that the English Customs should require that all brandy entered as such should be a grape spirit, and that no spirit should be entered as brandy when coming from a non-grape producing country without a satisfactory declaration that it originally came from a grape-producing country. He thought the only possible restrictions were by a declaration on the part of the shipper, or the counterfoils or foot-notes of existing forms of *aquits*; he believed that analysis could not be considered as an absolutely reliable proof of the purity or non-purity of Cognac brandy, as undoubtedly the constituent parts of alcohol varied in a greater or less degree, both in different years and by the more or less care devoted to distilling.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock :—

MARCH 17.—"The Musical Aspect of Drums." By GABRIEL G. CLEATHER. [The paper will be illustrated by short selections from the works of the great masters, with the assistance of Mrs. Stansfeld Prior at the pianoforte.] SIR CHARLES VILLIERS STANFORD, M.A., Mus.D., D.C.L., LL.D., will preside.

MARCH 24.—"Afforestation and Timber Planting in Great Britain and Ireland." By JOHN NISBET, D.Oec., late Conservator of Forests, Burma. The RT. HON. SIR CHARLES W. DILKE, Bart., M.P., will preside.

MARCH 31.—"St. Helena." By JOHN C. MELLISS, M.Inst.C.E., F.G.S.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

MARCH 25.—"Native Man in Southern India." By EDGAR THURSTON, Superintendent, Ethnographic Survey, Madras. LORD AMPTHILL, G.C.I.E., G.C.S.I., will preside.

APRIL 29.—"The Problem of Indian Labour Supply." By SELWYN HOWE FREMANTLE, I.C.S.

MAY 13.—"Some Phases of Hinduism." By KRISHNA GOBINDA GUPTA (Member of the Council of India).

MAY 27.—"The Function of Schools of Art in India." By CECIL L. BURNS, Principal of the Bombay School of Art. PROFESSOR SIR HUBERT VON HERKOMER, C.V.O., D.C.L., R.A., will preside.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock :—

APRIL 6.—"Ceylon: its Industries and Material Progress." By the Hon. JOHN FERGUSON, C.M.G. The Rt. Hon. SIR WEST RIDGEWAY, G.C.B., G.C.M.G., K.C.S.I., will preside.

APRIL 20.—"South Africa." By the Hon. CHARLES GIDEON MURRAY.

MAY 4.—

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

GEORGE GERALD STONEY, M.Inst.C.E., "Steam Turbines." Three Lectures.

LECTURE I.—MARCH 22.—Advantages of steam turbines—History of modern steam turbines—Principles on which they are constructed—Various types of steam turbines.

LECTURE II.—MARCH 29.—Applications of steam turbines—Exhaust turbines—Mixed pressure turbines—Condensers and vacuum augmentor—Turbo-dynamos and alternators—Turbo-pumps and compressors.

LECTURE III.—APRIL 5.—The marine steam turbine—Early history—"Turbinia"—Comparative trials between reciprocating engine and turbine ships—Application to war ships—The great express Cunarders, "Mauretania" and "Lusitania"—Conclusion.

F. W. LANCHESTER, "Aerial Flight." Three Lectures.

April 26, May 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 15...British Architects, 9, Conduit-street, W., 8 p.m. Mr. F. S. Swales, "American Architecture."

Victoria Institute, 1, Adelphi-terrace, W.C., 4½ p.m. Mr. H. M. Wiener, "Legislations of Israel and Babylonia."

TUESDAY, MARCH 16...Royal Institution, Albemarle-street, W., 3 p.m. Prof. F. W. Mott, "The Evolution of the Brain as an Organ of Mind." (Lecture IV.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. Wade's paper, "Concrete and Masonry Dam Construction in New South Wales."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 3½ p.m. Mrs. Douglas Cator, "Some Experiences of Colonial Life."

Statistical, 9, Adelphi-terrace, W.C., 5 p.m. Miss B. L. Hutchings, "Statistics of Women's Life and Employment."

Photographic, 66, Russell-square, W.C., 8 p.m. Mr. A. H. Dunning, "The Romance and Humour of Invention."

WEDNESDAY, MARCH 17...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Gabriel G. Cleather, "The Musical Aspect of Drums."

Meteorological, 25, Great George-street, S.W., 7½ p.m. Dr. Vaughan Cornish, "Wind Waves in Water, Sand and Snow."

Geological, Burlington-house, W., 8 p.m.

Microscopical, 20, Hanover square, W., 8 p.m. Dr. John W. Evans, "The Optical Examination of a Crystal Section in a Rock Slice."

United Service Institution, Whitehall, S.W., 3 p.m. Commander H. W. Richmond, "The Expedition to Sicily, 1718, Under Sir George Byng"

Dante Society, 38, Conduit-street, W., 8 p.m. Mrs. P. Chapman, "Illustrations of some of Dante's Allusions."

THURSDAY, MARCH 18...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linean, Burlington-house, W., 8 p.m. 1. Miss Sibyl Longman, "The Dry-rot of Potatoes." 2. Mr. A. Horne, "The Structure and Affinities of *Davidia Involucrata*, Baill."

Botanic, Inner Circle, Regent's-park, N.W., 4 p.m. Mrs. Bryant Sowerby, "The Sympathy of Flowers."

Chemical, Burlington-house, W., 8½ p.m. 1. Mr. M. M. P. Muir, "Iodine Dioxide." 2. Mr. C. W. Moore, "The Constituents of the Rhizome of Apocynum Androraemifolium." 3. Messrs. G. Barger and A. J. Ewins, "The action of Phosphorus Pentachloride on the Methylene Ethers of Catechol Derivatives. Part IV. Derivatives of Dihydroxyphenylacetic, Glycolic and Glyoxylic Acids." 4. Messrs. J. T. Hewitt, S. H. Newman, and T. F. Winmill, "Studies in the Azine Series. Part I. The Constitution of Safranine." 5. Mr. S. Ruhemann, "The Condensation of Amides with Esters of Acetylenic Acids." 6. Mr. J. C. Irvine, "A Polarimetric Method of Identifying Chitin." 7. Messrs. A. McKenzie and H. A. Müller, "Studies in a Symmetric Synthesis. Part VII. The Influence of the *d*-amyl Group."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. A. D. Hall, "Recent Advances in Agricultural Science." (Lecture II.)

Historical, Field-court, Gray's-inn, W.C., 5 p.m. Rev. C. E. Pike, "The Origin of the *Regium Donum* of the Church of Ireland."

Child Study, Parkes Museum, Margaret-street, W., 8 p.m. Mr. T. H. Hewitt, "Handicraft as a Factor in Mental Evolution."

FRIDAY, MARCH 19...Royal Institution, Albemarle-street, W., 9 p.m. Mr. R. Threlfall, "Experiments at High Temperatures and Pressures."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. C. J. Guttmann, "Some Aspects of Chemical Engineering."

Architectural Association, 18, Tufton-street, S.W., 7½ p.m. Mr. J. A. Marshall, "A Lesson from the Past."

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. Dr. Dempster Smith and Mr. R. Poliakoff, "Experiments upon the Forces Acting on Twist-drills when Operating on Cast-Iron and Steel."

SATURDAY, MARCH 20...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Sir J. J. Thomson, "The Properties of Matter." (Lecture IV.)

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MARCH 22nd, 8 p.m. (Cantor Lecture.) GEORGE GERALD STONEY, M.Inst.C.E., "Steam Turbines." (Lecture I.)

WEDNESDAY, MARCH 24th, 8 p.m. (Ordinary Meeting.) JOHN NISBET, D.Oec., late Conservator of Forests, Burma, "Afforestation and Timber Planting in Great Britain and Ireland."

THURSDAY, MARCH 25th, 4.30 p.m. (Indian Section.) EDGAR THURSTON, Superintendent, Ethnographic Survey, Madras, "Native Man in Southern India."

Further particulars of the Society's meetings will be found at the end of this number.

COUNCIL.

At the meeting of the Council on Monday, the 15th inst., Mr. William Charles Knight Clowes, M.A., was elected a member of Council, in place of the late Sir Owen Tudor Burne, G.C.I.E., K.C.S.I.

PRESENTATION TO MR. H. B. WHEATLEY.

At the Council Meeting Sir William H. White, K.C.B., F.R.S., Chairman of the Council, on behalf of the subscribers, presented to Mr. H. B. Wheatley, on the occasion of his retirement from the post of Assistant Secretary of the Society, a silver salver and a cheque for the balance of the subscriptions to be expended on the purchase of books. The salver bore the following inscription :—"Presented, together with a gift of books, to Henry Benjamin Wheatley by present and past Members of the Council of the Royal Society of Arts in recognition of his services as Assistant Secretary of the Society from June, 1879, to December, 1908."

Mr. Wheatley was also elected a Life Member of the Society, under By-Law 61, which empowers the Council to elect annually a certain number of Life Members free of all dues.

EXAMINATIONS.

The number of entries for the Society's Commercial Examinations, which commence on the 29th inst., is 31,627. The number of centres at which the Examinations will be held is 415. Last year there were 27,978 entries from 395 centres.

QUESTIONS AND ANSWERS.

In view of the fact that the Royal Society of Arts includes amongst its members authorities on almost every branch of human knowledge, it has been suggested that the value and interest of the *Journal* would be greatly enhanced if some space were devoted to correspondence of the "Notes and Queries" order. Readers in search of information on particular points which cannot be obtained from the usual books of reference, are, therefore, invited to make their wants known in the *Journal*, in the hope that they may be assisted in their difficulties by their fellow members. Further particulars will be found under the heading "Questions and Answers," on p. 382.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1s. 6d. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

FOURTEENTH ORDINARY MEETING.

Wednesday, March 17, 1909; Sir CHARLES VILLIERS STANFORD, M.A., Mus.D., D.C.L., LL.D., in the chair.

The following candidates were proposed for election as members of the Society:—

Carson, James Campbell, 8, Wellington-place, Belfast.
Datta, Dina Nath Prithu, M.D., Hoshiarpur, Punjab, India.
Garrod, James Best, 96, Lavender-grove, Dalston, N.E.
Mallik, Satyendra Chandra, I.C.S., care of Messrs. Grindlay and Co., Calcutta, India.
Sim Boon Kwang, 73, Scotts-road, Singapore, Straits Settlements.
Smith, Charles Arthur, Moorhill, Totley, near Sheffield.
Yow Ngan Pan, Chop Lo Kee Seng, 28, Market-street, Singapore, Straits Settlements.

The following candidates were balloted for and duly elected members of the Society:—

Barnes, Major Arthur Alison Stuart, 16, Hankow-road, Shanghai, China.
Schwabachr, Hermann, Ph.D., 48, George-street, Portman-square, W.
Strangways, Guy Ernest Alan, 56, Holland-road, W.
Wong Ah Fook, 31, Kling-street, Singapore, Straits Settlements.

The paper read was—

THE MUSICAL ASPECT OF DRUMS.*

By GABRIEL G. CLEATHER.

I hope it may not prove uninteresting for members of this learned Society to listen to one who is an enthusiastic believer in the music that can be obtained from drums, and who therefore was the more gratified at receiving an invitation from the Council of the Society to read a paper on musical instruments of percussion, because it seemed to show clearly that interest was at last beginning to be taken not only by musicians, but by those who are interested in music as an art, in these instruments, and more especially in the chief and most musical member of the family — the kettle-drum. I was the more gratified when I heard that Sir Charles Stanford had consented to take the chair this evening; and I must confess to an ardent desire—speaking under the presidency of so distinguished a musician—to be able to tell him something about drums he does not know; but if this be impossible, as I quite expect, I shall be equally pleased to learn something from him.

The percussion family in orchestral use in England includes the bass drum, tenor drum, side drum, tambourine, kettle-drums, cymbals, triangle, castagnettes, and xylophone, and I believe Richard Strauss is busily adding to the list!

I do not propose to-night to deal at length with any but the kettle-drums, or timpani.

The bass drum should have no appreciable note and is chiefly useful for emphasizing certain passages and for martial effects, but it is also capable of producing atmosphere. A roll on the bass drum is made with a double-headed stick, but modern composers often indicate the roll to be made with the timpani sticks, very softly, to get an atmospheric effect.

The tenor drum should also have no appreciable note. It is used chiefly for rolling passages in military bands where timpani are not available, and is very effective in the full orchestra in old rustic dances.

The side drum again must have no appreciable note, and this is secured in each case by straining the heads at different tensions, or employing heads of different thicknesses, which amounts to the same thing. A very important matter in a good side drum is the quality and delicate adjustment of the snares, which are six, eight, or more pieces of catgut stretched across the under or snare-head, the shell of the drum being sunk to allow of their complete contact with the head. Great judgment is required in the putting on of the snare-head, for if it is strained the wrong way of the skin the snares will be free of contact in the centre and will not respond to a piano roll.

The effect of these snares is to double the beats of the roll and give crispness. When muffled drums are used, as at a military funeral, it merely means that the snares are damped, and every side drum should have a damper attached to it, for otherwise so sensitive is it to vibratory action that the snares will keep up a continuous buzzing noise when the other instruments are played.

The difficulties of the side drum are so great that they can only be overcome by learning at a very early age. The various strokes on the side drum out of which all the combinations are evolved are the beat, the

* The right of reproduction is reserved.

flam, the drag, the ruff, the 5, 7, 9 and 11 stroke rolls, and the long roll technically known as the "daddy-mammy." It is a double roll, two beats with each hand, and the difficulty is to get the second, or repeat beat, exactly as loud as the first, and the two strokes with the left hand as even, and of the same weight, as those made with the right: it is generally the case that a boy's right hand is stronger than his left, but besides this the left stick has to be held in a perfectly different manner, and in one not nearly so good for either strength or flexibility.

The drummer boy being trained to learn the "daddy-mammy," has to go through a most wearisome exercise. He has to raise his arms up to his head between each beat. The object of this is to keep the buttons of the sticks always as far from the drum-head as possible, so that when the roll is closed, there may be no smudging, but a clear and perfectly even trill. It is a most difficult exercise, and is only mastered, in its absolute perfection, by few.

In the military drum duty the six and ten stroke rolls are sometimes employed, but they are not used in orchestral playing.

Probably the most difficult stroke on the side drum is that known as the double drag and stroke; done close, it brings the accents on the first, third, fourth and sixth beats of a $\frac{6}{8}$ tempo, and is very effective in military marching. All those effects on the side drum, that sound as if the player simply let his sticks fall on to the drum in a bunch as it were, are really an exact number of beats carefully timed and practised slowly for months before they can be closed. Thus the five stroke roll—the most common of the short rolls—consists of five distinct beats, and must be practised slowly.

I will conclude my remarks on the side and bass drums, by an illustration—by way of *divertissement*—of how the drummer-boy is taught his "daddy-mammy." It has been said that only an enthusiast can ever be a successful drummer, and I fancy when you see what the boy has to go through, it may increase your respect for his work; at all events, you can hardly fail to recognise his patience and perseverance.*

After the "daddy-mammy" we shall give just a very short illustration to demonstrate the atmosphere that can be given to the tone picture by the bass and side drums, as shown in the slow and quick movements of Suppé's overture, "Light Cavalry." The work is not a classic, but it will serve as an illustration.

Included among the percussion instruments are the cymbals. Even they can be played artistically, and there is such a thing as the pure cymbal tone. They should not be clashed, but rubbed together with a glancing touch to get the pure tone. All sorts of weird effects can be got from cymbals. They can be clashed loudly or gently, they can be struck with a hard or a soft stick, they can be rolled upon with hard or soft sticks, and great orchestral effects and tone-colour can be produced from them which many composers know how to use judiciously. Berlioz often obtained the most weird and fascinating effects from good cymbals, notably in the "Queen Mab" scherzo of his "Romeo and Juliet" symphony.

Now we come to the kettle-drums, generally known by their Italian name of timpani. These are what musicians refer to when they talk of drums. They are musical instruments in every sense of the term; they have—or ought to have—notes as clear and definite as the violoncello when played pizzicato, and can only be used when forming part of the harmony played by the other instruments. One of the many popular errors about kettle-drums is that their notes are in the same register as the double-bass. Not so, they are in the same register as the violoncello, and even the 'cello can go an octave lower than the lowest note obtainable on a kettle-drum.

I am not concerned to-night in saying anything about the difficulties of timpani playing. I should hardly know where to begin.

1. What is really supposed to be the greatest difficulty, namely the tuning, ought to be the smallest. It only wants a perfect musical ear, a fine sense of touch, and five years' experience.

2. A Timpanist is never so hard at work as when he is not actively employed, for he is then silently counting and watching his conductor.

3. The really difficult work is the dissecting of intricate bars of rhythm and playing them with two sticks on three or four notes some four or five feet distant from each other, and the problems composers sometimes set us are, to me, a never ending source of delight.

The selections, therefore, that I have chosen are not those which illustrate the difficulties of technique, but are intended merely to exhibit the timpani as tone-producers, and to show the value of true notes and the effect they have in producing atmosphere. If this can be done, even imperfectly, with a piano—itself an in-

* At Mr. Cleather's request the "daddy-mammy" was performed by a drummer of the Cameron Highlanders.

strument of percussion—how mnch greater will be its influence when combined with all the variety of tone of an orchestra, or an organ! Indeed, neither the orchestra nor the organ is complete without the timpani. Shall they be musical timpani? I think so. Let us try and illustrate what I mean in a little Berceuse by Grieg with a timpani part added by my friend, the late Dr. Sawyer.

There is not time at my disposal to-night to do more than touch upon one branch of the subject of the use of kettle-drums, and, therefore, I propose to limit what I have to say to the questions of tone quality, its necessity, if you are to have really musical drums, the manner in which I believe it may be obtained, and the use of drums for producing atmosphere. And the first question I would ask is: Do composers and conductors really want musical drums? It is a question between the tubby wooden tone with the vibrations muffled and the instruments used merely for the accurate expression of rhythm with only an approach at the atmosphere they can secure in the tone picture, and the singing bell-like tone of the really musical kettle-drums. I should very much like to hear an expression of opinion on this question from those who are not only great composers, but great conductors; but before they could really form a practical judgment on the matter, they would have to hear the same music played by an orchestra with an expert player on the machine-tuned kettle-drums, and then with musical drums such as I believe these to be, and choose between us as to which tone they preferred. The music chosen, however, should be of the kind that made the full use of the kettle-drum's quality of producing atmosphere as well as rhythm.

The construction of kettle-drums, as far as shape and material are concerned, has varied very little; the principal changes of late years have been that the shells are made much deeper—not always to the advantage of the smaller drums, I think—sliding feet have been introduced to avoid carrying stands about, and various methods have been tried to secure accurate and rapid tuning, notably that in use at the Queen's Hall, which, being the latest and most perfect of its kind, is the only one I shall notice to-night. But the most important and beneficial improvement has been in the manufacture of the heads and the extreme fineness of the skins, and the manner in which they are put on. As to the heads themselves, they used to be thick, opaque, and with a surface like sandpaper, now they are thin, transparent, and with a surface like satin; as to the way in which they are put on, a still greater improvement has been introduced which has had a marked effect on the purity of the notes.

In one of a series of admirable lectures on musical instruments delivered before this Society in 1891, viz., in that of the 7th August, by Mr. A. J. Hipkins, you were told that the kettle-drum was "a cauldron covered with a vellum head bound at the edge round an iron ring;" that was the method in use between thirty and forty years ago.

The objections to binding the head round the iron ring, or hoop, were twofold. First, the hoop has to carry the lugs or brackets for the tuning-screws, and therefore if the head is bound round it, slits have to be made in the vellum to allow it to pass over these lugs: consequently, when tension is applied, the head would not be strained evenly, and moreover just where the tension came the head would be weakened because of the slits, therefore a true, pure note would not be obtainable, and the drum would be always false. Second, the vellum head had to be put on damp, and though the hoops were painted and varnished, or even had they been enamelled and then baked, the rust would still come through and injure the head. Besides this, in order to make the slits as small as possible, the lugs were made small, with the result that the pressure all came at one spot.

For the last thirty years the heads have been lapped round flesh hoops, thus avoiding the slits, and I have made all my kettle-drums, as may be seen on examination, with brass brackets instead of iron lugs, rivetted on to the hoop, which is steel, and so spread the tension, thus securing a still purer note. Now we will test these notes by playing a melody which may be heard from this building every hour of the day and night.

The following is a little melody written to be played on 4 timpani that occurs in Meyerbeer's opera "Robert le Diable."

Now Meyerbeer wrote that 80 years ago, and yet, I venture to say that—outside of the musical profession—not one person in a hundred of those who listen to an orchestra in England to-day knows that timpani have notes and can give out a melody. Whose fault is it? The drums'? The players'? Or the listeners'?

If the drums are bad they will have no distinct notes. If the drums are good and the players have not musical ears, they cannot get the notes. If the drums and players are what they ought to be, and the listeners have not musical ears, they cannot appreciate the notes and the tone. Anyway the fact remains.

You cannot give people musical ears, but you can improve the drums, and therefore that seems to me to be a legitimate reason for such a Society as this seeking information on the subject.

I think the hoop and the fit of it are probably the most important things in the construction of kettle-drums. Much depends on the section of these hoops. They are generally made of iron, and of a section a little over a quarter of an inch thick and 5-8ths deep. Now a hoop on a 27-inch drum will be about 84 inches in circumference, and the seven tuning-screws will strain it at about distances of 12 inches apart, therefore if this pressure is to be evenly distributed the hoop must be very rigid not to buckle between the screws. The pressure, being vertical and not lateral, I think the material should be steel, and the section 5-32nds of an inch thick and ¾ of an inch deep, and then with the brackets made, as before mentioned, to spread the tension, something like an even pressure all round can be imparted; on this pressure being even depends mainly the purity and trueness of the note. Obviously, if the head be much strained at seven points, and the hoop weak enough to relax the pressure at other points, the note will be false. Another thing, a hoop of the section I suggest will be lighter, and all unnecessary weight about a kettle-drum stops the vibrations, and deadens the tone. Now we will play two of the pedal piano sketches of Schumann, where the timpani have little solo passages that stand out, and so will enable you to hear the notes clearly, and judge of their value.

The present extreme range of kettle-drums is from C below the stave to G in the top space in the bass clef—"present range" because, as the purity of the tone of the drums is improved, the range can no doubt be extended.

That this has been done already can be seen on reference to old and modern scores. So far as I know the old masters never wrote for the timpani in more than one octave, F to F; now we often come across the low E, old E flat, and sometimes the high G.

The statement, therefore, in the article in Sir George Grove's dictionary quoted to members of this Society in the lecture before alluded to that "drums below F produce mere thunder" may have been true at the time the article was written, but is not so now, as I will illustrate on this 32-inch drum. Whether it gives out a pure note or not you, being farther away, can judge better than I.

As to the sizes and form of kettle-drums, the article in Sir George Grove's dictionary gives the relative diameters of a pair of kettle-drums, theoretically, as 30 and 26 inches, and practically as 29 and 25½ inches, but these diameters do not agree with my experience. It is not even every 24-inch kettle-drum that can be taken up to F at the high pitch, and it certainly could not be effective below B. Again, a 30-inch kettle-drum could not—or, at all events, should not—be strained up to B.

To screw 26 and 30-inch kettle-drums up to F and B respectively is, I should say, an impossibility, and must result in something giving way.

For the modern orchestra three kettle-drums are a necessity and four are better, and the sizes I should suggest would be 31-inch with range from low D to A, 27-inch from G to C, 24-inch from B to F, and 22-inch from C to high G.

Promoters of concerts, or those who engage the orchestra, seem to think that if they see two kettle-drums written for in the scores of the various works to be performed, only two drums are necessary and engage accordingly. It is therefore desirable for the Timpanist to get a list of the works to be performed, or he may find himself in a serious difficulty. Supposing a programme were arranged, containing Hamish McCunn's overture, "Land of the Mountain and Flood," which requires the low F, Mendelssohn's "Rondo" which is written for the drums tuned in D and E, and the "Unfinished Symphony" of Schubert which requires the high F sharp, he would need four drums to do the works properly and could not manage even imperfectly with less than three, although each has only two notes in the timpani part.

I have dealt with the head and the hoop, and now for the shell. The most important thing I think about the shell is the material of which

it is made. Hard, well-hammered copper seems to me to give the purest and most bell-like tone, and let it be as thin as possible, as thin that is, as is compatible with strength. As to depth, I believe in deep shells for large drums, but not too deep for the smaller sizes. All kettle-drums flatten when struck heavily, and the deeper the shell the more they flatten. This is, of course, not so noticeable in the low notes, but in the high notes it is very marked if the shell be deep. Of course, the object of the deep shell is to secure more resonance, so, as I do not believe in deep shells for small drums and yet want resonance, I am trying sound-boxes to-night under my drums, on the principle of the Æolian harp, to prolong the vibrations. You can judge whether this is successful. What I want to do is to get the tone as near a singing tone as possible. Except when it is required for certain marked passages which the composer wants emphasized, I am anxious to do away with the thud. It is not necessary; the attack can be as definite without the bang, and it will be more musical and not offensive to sensitive ears. I want the musical note to be as prominent as possible, and the stroke that produces it as light as possible, and so to secure extreme delicacy. The more musical the note, the better the drums will mix with their more gifted brethren, and pure timpani tone will always come through; it is easy to make them prominent when dramatic or martial effects are wanted. A giant of power and a fairy of lightness are the two extremes. The kettle-drums may only have an octave and a half of notes, but there is no instrument that has a greater range of power, for none can be played more softly and none have more penetrating power, and, therefore, it is the more important that this power should come from a musical note, and not be the mere banging on a tub.

Besides, if you have drums with pure musical notes, you must have musicians with musical ears to play them; and what an advantage that would be! The Timpanist who has a musical ear, and to whom music is a language and more than rhythm—great as that is—will get effects from his instruments that will be undreamt of by the merely mechanical timpani player. Do not let it be said that such an one should have devoted his ear, his temperament, his soul to a higher instrument. There is no highest and no lowest in an orchestra. All are necessary, each has its own voice, and nothing but the best is good enough to interpret the works of great masters who have spent so much time and labour on them. You cannot afford to despise even the man who is wrongly called the "drummer." Supposing it were the case—which it is not—that he cannot do much good for the orchestra, at least, if he be not a thorough musician, he can do an infinity of harm.

As an illustration of nearly the full range of kettle-drums, we will now play Mendelssohn's Funeral March, to which I have dared to add a timpani part for five drums ranging from the low E to the high G.

Now that we have constructed our drum, the question is how to get the best out of it and all it has to give. I hold, as the result of my experience, that four things go to the making of good tone:—

1. A good instrument.

2. Properly balanced sticks with small heads and just the right substance of felt, neither too hard nor too soft.

3. The sense of absolute pitch and a fine sense of touch such as is requisite for the production of good tone on a stringed instrument.

4. And most important of all, a proper method of playing; not only accurate technique, but a method that will secure full vibrations.

Such efforts as have been made to improve the construction of kettle-drums have mostly been in one direction, and that is to simplify the tuning, one going so far as to give a dial on the side of the drum to show the player when he is in tune. It will be a sorry day for music if the use of this ghastly contrivance spreads to other instruments. Imagine violins and violoncelli with dials at the sides to inform the players when they have tuned their strings properly! In the case of the kettle-drum the machinery used to effect this simplification of tuning is so heavy that it increases the weight of the instrument three hundred per cent. A violin weighs something under one pound; supposing its weight were increased to about three pounds, would it have the same tone? Surely not. Now, all these machine-tuned drums have this defect, that the tone is ruined and the vibrations are stopped, and all for what? To secure rapidity of tuning, and perhaps to assist a player, whose ear is defective, to tune more accurately.

Well, if two kettle-drums could be made which would contain all the notes from C below the bass clef to G in the top space, I could understand it, but they cannot. As I have shown, there must be four drums to produce

this octave and a half of notes properly, and with four, by tuning ahead, you can tune quite rapidly enough and much more accurately, and, above all, secure a good, pure, musical tone for every note.

As to weight and cost, four timpani of the sizes I have suggested would weigh about two hundred pounds, and cost about £50, whereas the two machine-tuned drums would weigh nearly four hundred pounds and cost £56.

The best method yet introduced that I have seen for securing this rapid tuning is that in use in the Queen's Hall Orchestra. It includes three distinct adjustments — 1st, the usual tuning screws all round the drum; 2nd, the pedal arrangement for raising or lowering the note; and 3rd, one adjusting screw which might be termed a "weather screw," so that on a damp day this screw could be used to adjust at once the pedal to bring the head of the drum to the same relative tension that it would have on a dry day. You can tune these drums very rapidly, therefore, and can even play tunes on them if the tune is slow enough. Therefore, for rapid passages, the tuning arrangement, excellent as it is from a mechanical point of view, and leaving everything else out of account, is of no value; and, moreover, unless the manipulator is very expert, may be of worse than no value, for, if he presses a notch too far, an entirely wrong note is produced. *Per contra*, the real pure timpani tone is not to be obtained; it is, I suppose, smothered entirely by the machinery, which is so heavy that it takes two men to lift each drum.

You may have been accustomed to regard a drum as a somewhat coarse, rough instrument, and to say that "surely a drum is just a drum and has its tone, and you have only to hit it and you get that tone." There is nothing here, you may have thought, like the delicate handling of the bow of a violin player, where the luscious and ravishing effect of tone colour depends more on the method and the fineness of the nerve of the man than on the excellence of the instrument. But that applies to the kettle-drums equally with the violin. The tone is the man's, not the instrument's, in proof of which the following incident may be cited:— Not very long ago an eminent musician and conductor was comparing the beauty of the tone of the timpani used at a certain concert with the tubby, wooden sound of those used at another concert, and learnt to his astonishment that the same instruments were used at both concerts! The only difference was in the player.

Sir August Manns was so struck one day by the purity of the tone produced by the Timpanist in an orchestra which was entirely hidden that he wrote to the conductor and asked who the player was, remarking that he had never heard that tone except from a certain Timpanist. He was, therefore, not surprised to hear that the player was his pupil, and as such had acquired his method. You will notice that Sir August Manns did not ask what *drums* were used, but who was the player. As a matter of fact the drums were a very old pair and of poor quality.

These two expressions of opinion from eminent musicians capable of judging and free from bias seem to prove conclusively that the tone is the man's and not the instrument's, just as much in the case of the timpani as in that of any other instrument, for in the first instance the instruments were admittedly good and produced a fine and pure, or a tubby and bad tone according to the player; and in the second the instruments were poor and a good tone was produced from them.

As to its coarseness, Mrs. Stansfeld Prior has even consented to play the Rondo Capriccioso of Mendelssohn with me with a very full, but delicate, part written for four timpani by Mr. Sydney Faulks, Musical Director to Mr. Fred Terry, who is now at the New Theatre playing "Henry of Navarre." It is a daring experiment to put the drums with a pianoforte solo, and only to be justified by the result, and my desire to test this question of delicate tone under the most trying conditions.

To sum up then, if you want a good toned drum that shall have the musical notes:—

1. Let the shell be of well hammered copper, thoroughly planished.

2. Let the hoop be of steel of the section of $\frac{5}{32}$ inch by $\frac{3}{4}$ inch, and let it fit the shell truly and evenly all round.

3. Instead of lugs that are only $\frac{3}{4}$ inch wide, and rivetted on to the hoop at one spot, have brackets $2\frac{1}{2}$ inches wide, and rivetted in two places.

4. Let the head be even, shaved thin, fine in the grain, put on with the back of the skin across the drum away from the point of playing. Let it be put on a flesh hoop, and strained evenly.

Then if you have a Timpanist with a musical ear, and who is a musician, you will get as perfect a result as possible. But you will get

a better result from the ideal player, with poor drums, than from the indifferent player with the finest drums that could be made. It comes back to the old point of stopped vibrations, and I think this can best be realised by considering the difference in pianofortes of these days and fifty years ago. Probably the greatest improvement has been in the action, so that the hammers now leave the strings more quickly than formerly, and full vibrations are secured. It is just the same with drum playing. The player with the proper method gets his drumsticks away from the drum-head more quickly, and the head is free to vibrate. For this reason a roll on the kettle-drums should not be too close, and the side-drum "daddy-mammy"—or double roll—should never be used: it will stop the vibrations, muffle the tone, and kill the note at once.

How, then, shall we get players with the proper method? For the playing of the military drum duty there is a recognised method which has been handed down for generations; and when one listens to a good military band one is certain to hear good playing on the bass drum, the side drum, and the cymbals; but when you come to the timpani, there is in England no school of playing and no recognised method; the art is picked up somehow, and the result is, that when a conductor is faced by an unknown Timpanist, he never knows exactly what he is going to hear.

The timpani are the leading percussion instruments, and yet they are neglected by the founders of the schools in that no encouragement is given for great proficiency on them; there is no scholarship founded for these instruments as for others. Yet they are one of the few perfect instruments in an orchestra, for, like the strings and trombones, they are the only ones the scale of which can be perfect; these three alone can distinguish between any sharp note and its flat equivalent.

I want very much to found a scholarship to encourage the earnest study of these most difficult and beautiful instruments. Unfortunately I am not over-burdened with this world's goods, and the amount of money I could give towards such a desirable object would do no more than set the ball rolling; but I venture to think that the wealthy who are interested in music as an art and want, as I do, to see England occupy its legitimate place in music, might do a great deal towards improving what is sometimes found to be a weak spot in our lesser orchestras, by subscribing to a fund to found a Timpani Scholarship at one of our schools of music. In England we have an extraordinary idea that Timpanists are "Drummers" and therefore not necessarily musicians, whereas there is no instrument the playing of which in its perfection requires a more perfect musical ear, a finer sense of touch, or greater musicianship than the kettle-drum.

In Italy the two best paid members of the orchestra, after the leader, are the first horn and the Timpanist.

I must not conclude without thanking Mrs. Stansfeld Prior for her extreme kindness in playing for me this evening. For a great pianist to associate herself with drum playing is unusual, and my instruments and I acknowledge the compliment.

I also wish to acknowledge the debt I owe to Messrs. Hawkes and Son, the most conscientious drum manufacturers I have met with, for the loan of the bass, tenor, and side drums for my illustrations this evening, and also for the beautiful heads they continually supply for my timpani.

To finish, we will play a very short excerpt from the second movement of Brahms' great Requiem, containing probably as fine a specimen of rhythmic timpani writing as can be found.

DISCUSSION.

The CHAIRMAN (Sir Charles Stanford), in proposing a cordial vote of thanks to the author for his instructive paper, and to Mrs. Stansfeld Prior for her pianoforte accompaniments to the selections given, said it had been his fortune all through life to have a great respect and reverence for drums. He began with an early memory at the age of eight, when he remembered sitting next to the late Sir Charles Hallé at a concert, and, on hearing drums for the first time, he was ashamed to say that they made him cry. Sir Charles Hallé comforted his juvenile soul by telling him that, though he might be disturbed by the noise of the drums as they were played that evening, if he lived a little longer he would hear other noises that would make him cry a great deal more. His memories of drums might be illustrated by his recollections of what the author said were not to be called drummers, but timpanists. He remembered, first of all, Mr. Chipp, who, as Mr. Cleather probably knew, played the drums in a masterly manner at the Opera in the old days. Then there was a player at the Crystal Palace, under Manns, named Thompson, who generally used to arrive on the scenes just in time for the commencement of the performance. He used to take off his great coat after the music had begun, and spent a good deal of time

in arranging it on the back of the seat. Then, just when those who were watching the score expected that he would be certain to miss his note, he quickly turned round and gave the tap at the right moment. The player who succeeded him at the Palace was a gentleman named Smith, of whom he had been reminded that very day of an amusing little episode. Mr. Smith failed to appear one day at a rehearsal, and Manns enquired why he was absent; whereupon a German, who was playing the second violin, said that Mr. Schmidt would be present immediately. Now Manns also was a German, though he had lived for many years in England, and he turned round to the second violinist and said, "You have lived for a long while in England, and yet you do not know that his name is Schmiss." Then there was an excellent old player named Pheasant, who played for many years at the Opera, and of whom he had a tragic memory. Pheasant played for him at a concert at Cambridge, and on going home died within half-an-hour of his arrival at King's-cross; so that Pheasant's last performance on the drums was at a concert which he (the Chairman) conducted. There were now in Cambridge a very fine pair of drums which belonged to Pheasant, which were not unlike, both in pattern and shape, the drums the author has used in the selections he had played illustrative of the paper. Musicians owed one debt in particular to drums, viz., that as music was all founded in its essence upon rhythm, drums represented in the orchestra the strongest sense of rhythm of the entire orchestra. He remembered rather an amusing story which had a bearing on that point. That extremely witty man, Hans Von Bülow, once paid a visit to Milan to conduct the Ninth Symphony. In the Scherzo, where the drums are tuned in octaves, he could not make the drummer get the rhythm: he either made the first two notes too long, and the last two too short, or *vice versâ*. After a considerable time, Von Bülow lost his temper, and said to the man, who was an Italian, "What is the name of your instrument?" the man replying "Timpani;" whereupon Von Bülow exclaimed, "That's it—timpani, timpani, timpani!" There was a particular place for drums in that movement, which was marked "Forte," and many drummers, therefore, played it as loudly as possible—with such a smash that it was hardly possible to distinguish what the notes were. The drummer in question played fortissimo at this particular place, so Bülow stopped the orchestra, and said "Forte." The drummer simply played harder still, and, after two or three ineffectual attempts to make the man understand, Bülow said to him "Forte, not fortissimo." Bülow knew his Beethoven well. That was a lesson to all musicians not to play that passage, which Beethoven marked with one "f," with two, because it spoiled it. Musicians appreciated the value of the drums: they knew the misery they had to endure when they were badly played, and the joy they experienced when they were well played. As Richter had said, the three most important instrumentalists of the orchestra to the conductor were, the first hautboy, the second bassoon, and the drums; if they were good the rest was safe. Conductors relied upon those instruments for nearly all the "atmosphere," which formed such a large part of the joy that was obtained from orchestral compositions.

The resolution of thanks was carried unanimously, and Mr. CLEATHER having briefly acknowledged the compliment, the meeting terminated.

HOME INDUSTRIES.

The Cotton Spinning Trade.—Despite the seven weeks' stoppage in the cotton spinning industry, and the organised short time which preceded the closing of the mills, there is so much depression in that part of the industry which deals with the spinning of American cotton that at a special meeting of the American Section of the General Committee of the Federation of the Master Cotton Spinners' Association held last week, it was decided to send out a circular to the section of the members of the Federation using American cotton for the purpose of ascertaining their views on the question of organised short time working. The question addressed to the members is, "Are you willing to join in organised short-time working by closing your mills each Saturday or Monday, or their equivalent, to the end ot Whit week?" The replies have to be sent in not later than the 25th inst. The proposed stoppage, if agreed upon, will affect about eight million spindles. There is a good deal of difference of opinion among spinners as to the proposed short time, and it is thought that difficulty will be experienced in obtaining the necessary four-fifths majority. Meantime the figures for February show a heavy falling off in exports of cotton piece goods as compared with those for the same month of 1908, the shipments in February of that year being 506,125,200 yards, as against 435,688,500 yards last month. During February, the position of spinners of both American and Egyptian yarns got worse, and since the begining of this month individual cases of short time have increased. The off-take by home users and exporters has been less than the production of the spindles, and many producers have been forced to clear stocks at a loss in some instances of fully a half-penny per pound. Shipments of yarn, too, continue to decline, those for February amounting to 17,036,500 lbs. as compared with 19,804,200 lbs. for the same month last year. In some cases large contracts for yarn or cloth are on the books, but delivery is avoided. The imminent advance of tariff in France, and the probable reduction in tariff in the United States, add to the uncertainties of the hour, though how far, and exactly in what manner, they will lead to displacement of trade remains to be seen.

The Manchester Rainfall.—An interesting and important question has been raised by Mr. W. T. Hesketh, who directs attention to the diminishing rainfall of what may be called the cotton manufacturing district. The connection between the rainfall and the cotton industry is well known. The value to the cotton spinners of a humid atmosphere is great, inducing, as it does, increased output of their spindles; while the reservoirs attached to each little works attest the constant need of a large and uninterrupted supply of water. The crowding of mills, sheds, and works on the banks of streams is evidence of the intimate connection between the industry and water supply. Mr. Hesketh's contention is that there has been a marked diminution in the rainfall of the Manchester district. He has had access to records of rainfalls compiled for the last fifty years in connection with one of the great canal systems. These records are taken daily at nearly fifty places, from Grimsby on the east coast to Southport on the west coast; the gauges are situated on an area in a direct line from Lincoln to Hawarden, and between another line some thirty-five miles north from, say, Grimsby to Southport, and are at varying elevations above sea-level—according to the general elevation of the country. Mr. Hesketh divides the rainfall examined into two periods, from 1860 to 1886, and 1887 to 1908. The average rainfall of Manchester in the whole period was 32·27 inches; in the first period it was eighteen times much above the average, and nine times a little below it; in the second it was twice only a little above the average for the whole period, and twenty times below it. Taking the first period, 1860 to 1886, the average fall across the country was 33·16 inches, and in Manchester 36·00 inches, while in the second period, 1887 to 1908, the average across the country was 28·22 inches, and in Manchester 27·67 inches. In no one year of the second period did the Manchester rainfall reach the average of the rainfall for the first period. In the second period of 22 years the average rainfall of Manchester was 8·33 inches less than that of the preceding 27 years. Mr. Hesketh does not attempt to answer the questions that arise respecting water supply, streams, reservoirs, humidity of climate, prevailing winds, &c., but referring to the reports of sea captains that the Gulf Stream does not come out so far east as it did formerly, but has doubled back across the Atlantic, he asks if it can be that the westerly winds are not so cloud-laden as formerly.

Insurable Interest.—The judgment delivered in the Court of Appeal in Griffiths *v.* the Trustees of the United Kingdom Temperance and General Provident Institution is of great importance to the public as to insurance companies. The case turned on the validity of a joint life assurance made on the lives of husband and wife and, by its terms, payable on the failure of the first life to the survivor. The insurance company contested the policy on the ground, *inter alia*, that the husband as such had no insurable interest in his wife's life. It is not easy to understand why, if this was the view of the company, it issued the policy it afterwards repudiated. However that may be, it was very necessary that the point raised should be heard by the Court of Appeal, for it has been the occasion of much controversy and dispute. When the case came before Mr. Justice Pickford he ruled that while a husband might not, in many cases, have an insurable interest in his wife's life, in this case it had been shown that the husband had incurred extra expense by reason of his wife's death, and that this was sufficient to create an insurable interest. He laid it down as a principle that "where there was clear proof of actual loss" there was an insurable interest. The Court of Appeal has gone much further by deciding in distinct terms that a husband must be presumed to have an insurable interest in the life of his wife of precisely the same nature and extent as that of the wife in the life of her husband, "the personal interest," to quote Lord Justice Farwell, "founded on affection and mutual assistance," apart from any pecuniary interest.

Industrial Alcohol.—The necessity for cheap industrial alcohol has long been recognised, and it was believed that the Revenue Act of 1906 would result in such a cheapening of the commodity as to put consumers here in an advantageous position, as compared with consumers in Germany, whence competition is most to be feared. By that Act, a new variety of methylated spirit, to which the name of industrial methylated spirit was given, was authorised for use solely in arts and manufacture. In the case of this new spirit the amount of the denaturant was reduced by one-half, while an allowance was made on all spirit so methylated of 3d. per proof gallon, this being the estimated cost to the distiller of the revenue restrictions on the methylation of spirits. The maximum quantity of methylated spirits that a licensed retailer could keep in stock, and sell, was also raised from fifty gallons and one gallon, to two hundred gallons and four gallons respectively. The results of the Act, as regards prices, have been very disappointing. Before the passing of the Act, the price of methylated spirits was 1s. 8d. per gallon, whereas now it is from 2s. to 2s. 2d. per gallon, according to quality. The methylators lay the blame for the advance on the distillers, and this advance has been facilitated by the competition existing among the distillers, but this has been met by an arrangement whereby the methylators bind themselves under serious penalties not to sell their commodity below a certain minimum price. It remains to be seen whether the latest advance in price will make the importation of German potato spirit feasible. In 1902-3, as much as 1,212,000 proof gallons were imported, but in 1907-8 the import was only 4,300 gallons. The use of industrial alcohol has not increased in this country so rapidly as was expected. The Inland Revenue figures show that the quantity methylated in the financial year 1907-8 was 6,445,000

proof gallons, compared with 6,055,000 gallons in 1906-7, and 4 462,000 gallons in 1897-8.

The Artificial Stone Trade.—For some years past there has been a tendency to reduce prices in the artificial stone trade, and a price combination has now been formed with the object of raising them. Leicester is the chief seat of the industry in this country, and the local syenite is made into pressed concrete slabs. At Wigan slag is used, and granite at Shap and Threlkeld. Near Halifax artificial paving is made on a large scale from stone from the flag-rock beds, as well as from Norwegian granite. Many other works exist, at some of which hand-made slabs are mostly produced. These are not dear, and have the advantage in hardness over the machine-pressed flags, but they are rawer at the edges, and are commonly more slippery and less regular in wear.

The Price of British Wheat.—A very useful chart has just been published by Mr. George Bromhall showing the annual fluctuations in the price of British wheat since 1800, with records of some of the principal historical and political events influencing wheat prices. The average price is given for each year, and the general tendency of prices during the whole period. The figures show not only how much cheaper but how much steadier in price wheat has been since we began to depend largely upon foreign sources of supply. In two years, from 1801 to 1803, the average price of British wheat fell from over 119s. to 59s. per quarter. Between 1812 and 1815 it fell from 126s. 6d. to 65s. 6d., and between 1817 and 1822 it fell from 96s. to 44s. 6d. On the other hand, since 1869, when the shilling registration duty was removed, the annual average price has never been above 59s., the average of 1873, or below 22s., that of 1894, the extreme range during the last forty years being thus only 37s., as against 67s. 6d. during the years 1800-40.

CORRESPONDENCE.

THE BUDDHIST AND HINDU ARCHITECTURE OF INDIA.

If space can be afforded me for a rejoinder to Professor Macdonell's letter that appeared in the *Journal* of March 12th, I should like to say that I had hoped the name Vishnu in place of Siva would have been viewed as an obvious oversight due to the frequency of the former in the two or three sentences that preceded. What I had in my mind, however, was to emphasise the fact that a few symbols (as Professor Macdonell has himself shown), which we associate with modern Hinduism, can be traced back, on certain early Buddhist monuments, to at least 150 B.C., and, as he has told us, they are even mentioned in the Rigveda, say a thousand years still earlier. Under these circumstances it seems to me the Professor has forced an undesirably severe separation of symbols used as aids in devotional exercices from anthropomorphic idols. And this, perhaps, has led him to affirm (p. 321) that "the oldest remains of independent Hindu art, either sculptural or architectural, only date from several centuries after the beginning of our era. These considerations in themselves justify the presumption that Hindu architecture is derived from the older art of the Buddhists." Unless, however, it can be shown that the anthropomorphic idol of *Lakshmi* and the *trisula*, the serpent and other symbols were originally Buddhist, their existence on the Sanchi rail seems to countenance the presumption, viz., that they came into early Buddhism from a pre-Buddhistic faith—a faith which very possibly required idols and symbols. And if such were an inheritance, tolerated by early Buddhism, it can hardly be upheld as an unwarrantable conjecture that the people from whom they were derived very possibly themselves erected houses or temples in which to place their idols or religious symbols. In other words we have to accept pre-Buddhist wooden sculpture and architecture as very nearly a certainty.

As opposed to this view, I understand that in another lecture (on this subject) Professor Macdonell said:—"There is no evidence that any of the early Indian religions made images of their gods." In consequence of that view he came to the conclusion that it was "not unlikely that Europe gave the first impulse to the immense worship of idols which now prevails in Buddhist countries as well as in India." But surely before accepting so very definite a pronouncement it becomes essential for us to consider whether the idols and symbols of the Buddhist topes were invented by the Buddhists or had only crept into Buddhism from a pre-Buddhist faith. It seems to me beside the issue to contend that because no independent Hindu monument of an early date has survived that shows idols therefore idols were not used prior to the phase of Buddhism when that faith itself became idolatrous. Is it not highly probable that the Buddhists up to a certain point simply carried forward and perfected the arts and architecture of the pre-Buddhist peoples, on lines perhaps parallel to those followed contemporaneously by the Jains and the Hindus? But we are promised a complete expression of Professor Macdonell's views and interpretations of this and other most interesting problems of Indian architecture, and it is, therefore, unfair to criticise isolated sentences or even an abstract lecture, such as is alone possible in the time allowed by the Royal Society of Arts.

In venturing, therefore, to differ from Professor Macdonell at all, I do so purely and simply on the basis of art and architecture, not Sanskrit literature, nor even Hindu mythology. I spent many years of my Indian life studying the arts and industries of that country, and, I confess, have come (rightly or wrongly) to think that while India doubtless derived much from her neighbours and even her conquerors (as most countries similarly placed have done), still in all ages there have existed, as there exists to-day,

aspirations and feelings that are distinctly Indian; and I accordingly give a foremost place among Indian archæological conceptions, to the sudden appearance of the fully matured *chaitya* That is to me a far more interesting feature in the story of Buddhist developments than the comparatively modern evolution of the *stupa* into the Chinese pagoda. Like Fergusson, I have always viewed the lineal descent of the pagoda as so self-evident that it was, perhaps, hardly necessary to indicate the successive steps by which the ultimate manifestation had been attained. The evolution or growth of the *chaitya* was practically completed when it is first brought to our attention in the cave temples. It is, in other words, impossible to believe that the idea of, and the necessity for, the *chaitya* could have been at once attained on the desire having arisen to excavate temples out of the solid rock. It seems far more natural to think that the perfection reached in wood had itself suggested the desirability of a more durable material being employed. Familiarity with the new material was accordingly all that was needed to allow the old building skill and the matured art conceptions to be faithfully rendered. Little surprise need, therefore, be felt that none of the experimental stages have survived. The wooden character of the early *chaityas* shows the persistence of ideas that had almost attained the position of sacred associations before they had been rendered in stone, and such could not, therefore, at once be rejected even when they had become obviously superfluous as structural features. The knowledge and skill—the engineering precision one might call it—which all this involves carries the *chaitya* far into pre-Buddhist times and renders it one of the central features of Indian architecture. In many directions the *chaitya* can be shown to have influenced the subsequent growth of Hindu and Mohammedan art and architecture. It was on this account that I ventured to repeat Fergusson's suggestion that the *chaitya* might be looked for in certain of the temples found erected by the primitive hill tribes of the tract of country adjacent to the region where Buddhism originated. The explanation offered by Colonel Hendley (and which Professor Macdonell now tells us he shares) when he enquired of me "Whether many of the pagodas in the hills were not forced upon the hill people by the Nepalese, and, whether they were not, to a certain extent, Buddhist, having been derived from the architecture of the plains," raises two questions to which I would give the following reply:—

1st. The Gurkhas date their sovereignty from the middle of the eighteenth century, and hence their conquests in the North-West Himalayas are too recent to have had any influence on the architecture west of Nepal, and south of the upper basins of the Sutlej, Ravi and Chenab. Moreover, they were Hindus who conquered the Newars or Buddhist inhabitants of Nepal. There is, so far as I am aware, no record of the Buddhist or original inhabitants of Nepal having ever conquered westward.

2nd. Acceptance of Colonel Hendley's suggestion would create a dilemma, namely, while in Nepal itself and during its eastward migration, the *stupa* manifested a progression into many umbrellas, westward a reversion took place since, in the region indicated, the Tee-like structure has never more than one protecting umbrella. And what is, perhaps, even more curious, it is never placed over a *stupa*, but protects the further extremity, or apse, of a temple, much as the Jaina-like sanctuary is placed on the top of the many-storied temple of Pagan.

3rd. If we follow the acceptation of "pagoda" implied by Professor Macdonell's lecture, namely, a structure that may be defined as a development of the *stupa*, then there are no pagodas within the country indicated by me, and the word temple had better be substituted. But it is quite customary, both in the Eastern and Western Himalaya, as well as throughout the mountainous frontier of Assam, to come across commemorative demon or trophy cairns, as also praying cairns, while both in Sikkim and the Khassi hills relic mounds and memorial stones are common. So also throughout Bengal the habit exists of erecting carved wooden posts in memory of deceased relatives. Thus, it may be said, one of the objects of a *stupa*, at all events, is very generally upheld in India to the present day.

4th. But the special temples to which I allude are certainly not Buddhist, and neither Hindu priests nor Buddhist monks, as a rule, officiate at them. In the extreme north of the area certain temples, however, are met with where both Hindu and Buddhist worship takes place, under the self-same roofs, for example, in the famous temple of Triloknath, in the Upper Chenab Valley. The Buddhism there seen obviously came across the Central Himalaya from Western Tibet, and was thus, as it were, returned to India till it met the wave of Hinduism ascending the valleys.

It will thus be seen that I cannot accept Colonel Hendley's suggestion. In other words, I believe that the special art and architecture of the country indicated is purely and simply indigenous, and has neither been influenced by the Buddhism of Nepal nor by the ancient Buddhism of the plains of India, though it is no doubt a fact that both Buddhism and Hinduism had invaded certain portions of the area, such as the valleys of Kangra and Kashmir.

GEO. WATT.

March 17th, 1909.

DEW-PONDS.

I should be grateful to you if you would allow me to reply to the two letters appearing in your issue of March 12th, under the above heading.

The point raised by Mr. Leeming is one that I ought to have included in my paper which I had the pleasure of delivering on March 3rd.

It is no doubt very largely owing to the affinity that the chalk has for moisture that the straw bed underlying the clay surface of the pond is kept dry, and I am very grateful to Mr. Leeming for having called attention to this point.

Mr. Carey's* letter, however, may lead some readers to a wrong conclusion, on certain material points, and these I should like to see corrected before a settled misunderstanding becomes established.

Mr. Carey is kind enough to say that my paper on "Dew-Ponds" deals fully with the physical causes by which dew-ponds operate. He goes on to say, "One other aspect is that of their use by primitive man as a means of water supply," and then Mr. Carey refers to a little book of his own, "Prehistoric Man on the Highlands of East Surrey," in which that side of the question is discussed.

Mr. Carey, however, does not refer to a previous publication, "Neolithic Dew-ponds and Cattleways," the joint work of Dr. Hubbard and myself. It was, however, from this book that Mr. Carey did us the honour of making lengthy quotations, and from which he found the whole support of the evidence as to the antiquity of dew-ponds. I purposely refrained from enlarging upon the antiquity of the dew-pond in my paper, but if Mr. Carey will kindly refer to the publication of it in the Society's *Journal* of March 5th, he will find that it was not entirely omitted, but that the material point is stated that it was Dr. Hubbard "who first showed that these ponds furnished the principal water supply to those prehistoric races who lived on the hill tops on the South Downs thousands of years ago."

Before dropping the subject of Mr. Carey's letter, there is one other matter to which I should like to make reference. Mr. Carey says that "the problem of water supply in miniature is fascinating, and I have patented methods for effecting this purpose." The cheapest and probably the best method for obtaining a water supply in this country would be by sheeting a sloping surface of land with corrugated iron upon a wooden backing. No patent is required for this.

From the numerous letters I have received since giving my lecture I gather that serious attempts, on a scientific basis, will be made to obtain water, and water, too, in abundance, where it is urgently needed in Western Australia and South Africa, and elsewhere.

George Hubbard.

March 15th, 1909.

* By an unfortunate oversight, Mr. Carey's name was printed Casey in last week's *Journal*.—Ed.

WHEAT ELEVATORS FOR INDIA.

The expansion of the foreign exports of wheat from India show beyond cavil its possibilities in the future. Thus, in 1872-3 these exports came to 394,010 cwt.; in 1882-3 they were 14,144,407 cwt.; in 1892-3 were 14,973,453 cwt.; and in 1902-3 stood at 10,292,150 cwt.; while during the succeeding four years they were (1903-4) 25,911,312, (1904-5) 43,000,502, (1905-6) 18,750,467, and (1906-7) 16,028,914 cwt. Thus, although extreme fluctuations have taken place, the movement has been distinctly forward.

There may, however, be said to be certain important controlling influences, such as:—

(*a*.) The supply and price ruling in Europe for other wheats against which India has to compete.

(*b*.) The restrictions and enhancements of cost, imposed by refraction (adulteration).

(*c*.) The extent of production of the special grades of wheat alone demanded by Europe.

(*d*.) The conditions of the India food markets—famine or plenty; and

(*e*.) The facilities of transport within India.

Perhaps exchange had some small influence in the past, but the fluctuations in the wheat trade cannot be said to have manifested a synchronous relation to the value of silver. Of far greater importance are improvements in agricultural methods and materials and the cheapening of freight and other charges from the field to the consumer.

Under the last category would fall the issue raised by Mr. Frederick Noël-Paton, namely, the advisability of introducing wheat elevators and grain storehouses. I have no personal knowledge of this subject, but the present is not by any means the first occasion of its being brought to the attention either of the merchants or of the Government of India. I suspect, however, the elevators are not likely to come into extensive use until the time has arrived when the fixation of the standards of sale will be made at the port of shipment. I confess I do not follow Mr. Noël-Paton in his "moral atmosphere of India." I have, in fact, little hesitation in believing that with the progress of commerce and enterprise the disabilities alike of refraction and of a moral atmosphere will disappear.

As matters stand at present the issue seems to be—would it be more advantageous to provide facilities of safe storage than to increase the rolling stock of the Indian railways and to improve the methods of shipment? Is it the fact that India "throws" its wheat exports more immediately on the European markets than is the case with other field of producion I have at present no means of answering that question, but there seems to me another equally important issue, namely: Is it a fact or not that India enjoys an advantage through the season of the year at which its wheat finds its way to Europe? The bulk of the Indian crop is obtained from March to May, thus considerably before the season of the European crop. If this gives India an advantage, then increased and more perfect methods of export would be decidedly preferable to protection against the undoubted dangers of Indian storage, which protract despatch.

Geo. Watt.

March 17th, 1909.

OBITUARY.

Henry Messervy.—The death occurred in Jersey, on the 3rd inst., of Mr. Henry Messervy, of Georgetown, British Guiana, at the age of 51. Mr. Messervy was a native of Jersey, and he was seized with pneumonia on his return home after an absence of nearly 25 years spent in the West Indies. He was well-known as an expert in the diamond trade and was general manager of the most important diamond mine in British Guiana. He was elected a member of the Society of Arts in 1903.

QUESTIONS AND ANSWERS.

ANSWERS TO CORRESPONDENTS.

On all communications must be written the name and address of the sender, not necessarily for publication, but as a guarantee of good faith.

Each question or reply should be written on a separate sheet of paper, and should bear such signature of the writer, and such address as he wishes to appear.

Questions which can be answered from the usual books of reference, will not be printed.

QUESTIONS.

Ambitty.—I should be glad of any information with regard to the etymology and history of the term "ambitty." It is used by glass-makers of glass when it begins to devitrify.—Noel Heaton.

Japanese Waltzing Mice.—What is supposed to be the reason of the characteristic action of these animals?—John Rawstorne.

Afforestation Profits.—What is the proportion of profits to expenses in the State-managed forests of Germany?—W. Aylwin.

ANSWERS.

Wren's Plans for Re-building London.—Immediately after the great Fire of London, in 1666, three distinguished men - Christopher Wren, John Evelyn, and Robert Hooke—submitted to Charles II. plans for the re-building of London on an improved arrangement of the streets and buildings. An engraving of Wren's plan was published in Wren's "Parentalia," 1750 (opposite page 268), in illustration of a chapter in that book on "Proposals for Rebuilding the City of London." It is described as the "Model of the New City, according to the Grand Design of Sir Christopher Wren," and we read,—"Wren made a design, and laid it before Parliament, for rebuilding the City of London, and a detailed estimate of the damage sustained, which amounted to £10,780,500. He was appointed architect to St. Paul's, and for rebuilding the whole City." It is to be regretted that more details are not given in the "Parentalia," as to what was really done. Wren's plan has been reproduced in almost every illustrated book on Old London. When it was brought before the House of Commons, Wren was present to explain his views. Unfortunately, circumstances were too powerful to allow of the carrying out of his scheme, but doubtless advantage was taken of his knowledge when the provisions of the Acts of Parliament (18 and 19 Car. II., capp. 7, 8), passed to regulate the work of rebuilding, were arranged.

If Wren's plan had been carried out, the City would have been much handsomer, and more convenient than it was, or ever is likely to be, but the insurmountable difficulty in the way was the aversion of the citizens to any alteration of their old properties. Wren proposed to build main thoroughfares north and south, east and west; to insulate all the churches in conspicuous positions, to form the most public places into large piazzas, to unite the halls of the twelve great companies into one regular square annexed to the Guildhall, and to make a fine quay on the bank of the river from Blackfriars to the Tower. The Exchange was to stand free, and to be as it were the centre of the town. St. Paul's was to stand like the narrow end of a wedge formed by the two straight streets from Ludgate to Aldgate and to Tower Hill respectively, and many streets were to radiate from London Bridge. The whole area of the City was to be levelled, and blind alleys, inferior buildings, graveyards, and noxious trades were to be excluded.

In *The Builder* for July 3, 1875, will be found a double-paged bird's eye view of London as it might have appeared if Wren's plan had been carried out. It is entitled "A Vision of the City of London," constructed on the plan left by Sir Christopher Wren, drawn and engraved by Mr. Worthington G. Smith under the direction of Mr. Godwin. This view originated in an attempt to illustrate a proposed paper to be read by the late Sir Edwin Chadwick before the Society of Arts on the building or re-building of cities. The reading of the proposed paper was postponed, and the view was subsequently published in *The Builder* by itself.

Evelyn's plan differed from that of Wren chiefly in proposing a street from the Church of St. Dunstan's in the East to the Cathedral, and in having no quay or terrace along the river. He wished, however, to employ the rubbish he obtained by levelling the streets for filling up the shore of the Thames to low water mark, so as to keep the basin always full. Evelyn, in a letter to Sir Samuel Tuke, wrote, "Dr. Wren got the start of me, but both of us did coincide so frequently that His Majesty was not displeased." Evelyn's plan, which though good in itself, is not the equal of Wren's in its bold design, has been frequently reproduced in books on London, one of the latest being "Memorials of Old London," 1908, vol. ii., p. 82.

do not think Hooke's plan has been reproduced. On September 19, 1666, Robert Hooke exhibited his model for rebuilding London before the Council of the Royal Society, and it is said that the Lord Mayor and Aldermen preferred it to Wren's plan. All the chief streets were designed to run in an exact straight line, and all the cross streets to turn out of these at right-angles. All the churches, public buildings, market places, and the like were to be arranged in proper and convenient places. Doubtless the preparation of this plan had something to do with Hooke's appointment as City Surveyor, in which office he assisted Wren in the great work of rebuilding London. An excellent proposal was made by Colonel Birde in the House of Commons for the purpose of carrying out a uniform plan for rebuilding. It was that the whole ground of London should be sold and placed in trust, and that the trustees should sell again, with preference to the former owners. Unfortunately it was not possible to adopt this simple proposal. However much we may regret that a great opportunity was lost, we must admit that there were great difficulties in the way of carrying out the proposed schemes. Although what was done was not ideal, it was a great improvement upon what had been done before. The Acts of Parliament already referred to were practical and altogether excellent. The way the provisions of the Acts were carried out under the legal superintendence of Sir Matthew Hale was complete, and gave almost universal satisfaction. Henry Oldenburg, Secretary of the Royal Society, writing to Robert Boyle, on September 10th, 1666, says:—"The citizens, instead of complaining, discoursed almost of nothing but of a survey for rebuilding the City with bricks and large streets."

The full history of this business has still to be written, and it would form an honourable chapter in the history of our country.—H. B. Wheatley.

Sheep in Australia.—I have not been able to ascertain when or by whom sheep were introduced into Australia. The earliest reference to them known to me is in a despatch written by Captain Arthur Philip, one of the first British Governors at Sydney, in 1788, in which he complains of the losses in his flock. I think, however, we may regard Captain John MacArthur as the founder of the Australian wool trade. Sent to Australia in 1790 on military service, he soon turned his attention to agriculture, and his experiments in sheep-breeding did much to improve the quality of Australian wool.—Melbourne.

Weevils.—I think "Miller" cannot do better than follow the instructions issued by the Board of Agriculture if he wishes to get rid of weevils from his grain. The instructions are as follows:—

"1. Fumigation with bisulphide of carbon is a very satisfactory way of ridding grain of the insects. The grain to be treated should be put in a bin or air-tight receptacle, and the bisulphide of carbon poured into a saucer or shallow vessel and laid on the top of the grain. The liquid quickly volatilises, and the fumes, being heavier than air, sink down through the grain and kill all insect life; 1 lb. of bisulphide of carbon is sufficient for 100 bushels of grain. The air-tight receptacle should be kept closed from 24 to 48 hours. A shorter time would do for small quantities of grain. In treating a store or mill, 1 lb. of bisulphide of carbon is sufficient for every 1,000 cubic feet of space. Before entering the mill after such fumigation the doors and windows must be thrown open for an hour or two in order that the place may be well ventilated. If necessary a second fumigation may follow the first.

"Bisulphide of carbon has a very disagreeable odour, and as the fumes are poisonous they should not be breathed, though a little will do no harm. It is also explosive, and must be handled with care. No naked light should be brought near it, nor should the operator smoke.

"2. Infested grain may be run through a sieve or a screen, the meshwork of which is sufficiently fine to keep the grains back and yet let the weevils fall through, these being caught in a receptacle placed underneath containing paraffin. This sieving or screening, however, fails to reach grains that contain eggs or developing larvæ. The same objection can be urged against the practice of screening under a strong air blast, for infested grains will still, to some extent, remain behind.

"3. For cargoes in ships thorough ventilation should be practised, this keeping down the temperature and ensuring dryness of the grain."—J. Mayne.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

March 24.—"Afforestation and Timber Planting in Great Britain and Ireland." By John Nisbet, D.Oec., late Conservator of Forests, Burma. The Rt. Hon. Sir Charles W. Dilke, Bart., M.P., will preside.

March 31.—"The Island of St. Helena." By John C. Melliss, M.Inst.C.E., F.G.S.

Meetings after Easter.

April 21.—"The Foundations of Stained Glass Work." By Noel Heaton, B.Sc., F.C.S.

April 28.—"The Resources of the Peruvian Andes and Amazon." By C. Reginald Enock, F.R.G.S.

May 5.—"English Furniture Design and Construction." By Percy A. Wells.

May 12.—"The Principles of Heredity as Applied to the Artificial Production of new forms of Plants and Animals." (Aldred Lecture.) By Professor Arthur Dendy, D.Sc., F.R.S., F.L.S.

May 19.—"Railway Development in China." By Arthur John Barry, M.Inst.C.E.

MAY 26.—"The Manufacture of Nitrate of Lime from Atmospheric Nitrogen." By SAM EYDE.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

MARCH 25.—"Native Man in Southern India." By EDGAR THURSTON, Superintendent, Ethnographic Survey, Madras. The RT. HON. LORD AMPTHILL, G.C.S.I., G.C.I.E., will preside.

APRIL 29.—"The Problem of Indian Labour Supply." By SELWYN HOWE FREMANTLE, I.C.S.

MAY 13.—"Some Phases of Hinduism." By KRISHNA GOBINDA GUPTA (Member of the Council of India).

MAY 27.—"The Function of Schools of Art in India." By CECIL L. BURNS, Principal of the Bombay School of Art. PROFESSOR SIR HUBERT VON HERKOMER, C.V.O., D.C.L., R.A., will preside.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock :—

APRIL 6.—"Ceylon: its Industries and Material Progress." By the Hon. JOHN FERGUSON, C.M.G. The RT. HON. SIR WEST RIDGEWAY, G.C.B., G.C.M.G., K.C.S.I., will preside.

APRIL 20.—"South Africa." By the HON. CHARLES GIDEON MURRAY. LORD BRASSEY, G.C.B., D.C.L., LL.D., will preside.

MAY 4.—

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

GEORGE GERALD STONEY, M.Inst.C.E., "Steam Turbines." Three Lectures.

LECTURE I.—MARCH 22.—Advantages of steam turbines—History of modern steam turbines—Principles on which they are constructed—Various types of steam turbines.

LECTURE II.—MARCH 29.—Applications of steam turbines—Exhaust turbines—Mixed pressure turbines—Condensers and vacuum augmentor—Turbo-dynamos and alternators—Turbo-pumps and compressors.

LECTURE III.—APRIL 5.—The marine steam turbine—Early history—"Turbinia"—Comparative trials between reciprocating engine and turbine ships—Application to war ships—The great express Cunarders, "Mauretania" and "Lusitania"—Conclusion.

F. W. LANCHESTER, "Aerial Flight." Three Lectures.

April 26, May 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 22...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. George Gerald Stoney, "Steam Turbines." (Lecture I.)

Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on Mr. J. George Head's paper, "Giant London."

Geographical, Burlington-gardens, W., 8½ p.m. Captain S. S. Butler, "A Recent Journey through Northern Arabia."

East India Association, Caxton-hall, Westminster, S.W., 4½ p.m. Mr. R. F. Chisholm, "Indian Industrial Development."

TUESDAY, MARCH 23...Asiatic, Burlington-gardens, W., 4 p.m. Dr. M. Aurel Stein, "Explorations—Archæological and Geographical—in Eastern Turkistan and Western China."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. F. W. Mott, "The Evolution of the Brain as an Organ of Mind." (Lecture V.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. A. Mallock, "The Construction and Wear of Roads."

Photographic, 66, Russell-square, W.C., 8 p.m.

WEDNESDAY, MARCH 24...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. John Nisbet, "Afforestation and Timber Planting in Great Britain and Ireland."

United Service Institution, Whitehall, S.W., 3 p.m. Col. H. W. Pearse, "The French Raid in Ireland, 1798, and Short Sketches of Other Attempts and Landings on the Coast of the United Kingdom."

THURSDAY, MARCH 25...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Mr. Edgar Thurston, "Native Man in Southern India."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Chemical, Burlington-house, W., 4 p.m. Annual General Meeting. Address by Sir Wm. Ramsay (President), on "Elements and Electrons."

Child Study, Parkes Museum, Margaret-street, W., 8 p.m. Prof. J. H. Muirhead, "The Religious Difficulty in the Light of Mind Study."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. G. A. Bryan, "Aerial Flight in Theory and Practice." (Lecture I)

Botanic, Inner Circle, Regent's-park, N.W., 4 p.m. Prof. W. B. Bottomley, "Remarkable Plants in the Society's Victoria Regia House."

FRIDAY, MARCH 26.. Aeronautical (at the HOUSE of THE ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.), 8 p.m.

Royal Institution, Albemarle-street, W., 9 p.m. Mr. A. S. Eddington, "Recent Results of Astronomical Research."

Physical, Imperial College of Science, South Kensington, S.W., 5 p.m. 1. Prof J. A. Fleming and Mr. G. B. Dyke, "Note on the Production of Steady Electric Oscillations in Closed Circuits and a Method of Testing Radiotelegraphic Receivers." 2. Prof. J. A. Fleming and Mr. H. W. Richardson, "The Effect of an Air Blast upon the Spark Discharge of a Condenser Charged by an Induction Coil or Transformer." 3. Dr. S. W. J. Smith, "The Action between Metals and Acids and the Conditions under which Mercury Causes Evolution of Hydrogen."

SATURDAY, MARCH 27...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Sir J. J. Thomson, "The Properties of Matter." (Lecture V.)

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MARCH 29th, 8 p.m. (Cantor Lecture.) GEORGE GERALD STONEY, M.Inst.C.E., "Steam Turbines." (Lecture II.)

WEDNESDAY, MARCH 31st, 8 p.m. (Ordinary Meeting.) JOHN C. MELLISS, M.Inst.C.E., F.G.S., "The Island of St. Helena."

Further particulars of the Society's meetings will be found at the end of this number.

QUESTIONS AND ANSWERS.

In view of the fact that the Royal Society of Arts includes amongst its members authorities on almost every branch of human knowledge, it has been suggested that the value and interest of the *Journal* would be greatly enhanced if some space were devoted to correspondence of the "Notes and Queries" order. Readers in search of information on particular points which cannot be obtained from the usual books of reference, are, therefore, invited to make their wants known in the *Journal*, in the hope that they may be assisted in their difficulties by their fellow members. Further particulars will be found under the heading "Questions and Answers," on p. 400.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURE.

On Monday evening, March 22nd, Mr. GEORGE GERALD STONEY, M.Inst.C.E., delivered the first lecture of his course on "Steam Turbines."

The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION.

Thursday afternoon, March 25th; the Right Hon. LORD AMPTHILL, G.C.S.I., G.C.I.E., in the chair.

A paper on "Native Man in Southern India" was read by EDGAR THURSTON, Superintendent Ethnological Survey, Madras.

The paper and discussion will be published in a future number of the *Journal*.

FIFTEENTH ORDINARY MEETING.

Wednesday, March 24th, 1909; The Right Hon. Sir CHARLES WENTWORTH DILKE, Bart., M.P., in the chair.

The following candidates were proposed for election as members of the Society:—

Conn, W. J., Railway and Civil Engineer, State Railway, British North Borneo, Papar, *viâ* Jesselton, British North Borneo.

Greenwood, H. B., The Pacific and European Telegraph Company, Necochea 183, Mendoza, Argentina, South America.

The following candidates were balloted for and duly elected members of the Society:—

Arbuthnot, Lieut. Colonel G. H., care of Messrs. H. S. King and Co., 9, Pall-mall, S.W.

Buck, Sir Edward Charles, K.C.S.I., LL.D., care of Messrs. H. S. King and Co., 65, Cornhill, E.C.

Dunlop, David John, Inch Works, Port Glasgow, Scotland.

King, Henry, F.R.H.S., 100A, Queen Victoria-street, E.C.

Sherali, Hon. Shaikh Sadikali, Khairpur, Sind, India.

The CHAIRMAN, in introducing the reader of the paper, said he was present to be shot at, because in the discussion which was supposed to have taken place upon the topic in the House of Commons he was reported as having said that the recent scheme laid before Parliament was finance of a wild-cat order. He did not, however, make that statement in a debate on forestry, but on unemployment, Mr. Guest, the Chairman of the Royal Commission, having brought the subject of forestry forward as a remedy for casual unemployment. On that occasion he said he feared that the calculations that "were laid before them, so far as England was concerned, could not be accepted as financially sound." He carefully excluded Scotland, Ireland, and Wales from what he said, because the evidence with regard to Scotland was very strong. Ireland had always been treated separately, and the Commission made a case, though he felt it was rather a doubtful one, with regard to Wales. As for the very large scheme laid before the House, which the paper described as outside the terms of reference to the Commission on Coast Erosion, he feared that the cause of afforestation might be found to have been damaged by the rather loose finance with which it had been there associated so far as concerned the chance of a great coniferous afforestation scheme in England being a paying concern. There had been four enquiries recently made into the matter. The latest of all, in 1908, on which the cause of afforestation was represented by Mr. Rider Haggard and Prof. Somerville, reported on afforestation as a means of increasing employment during periods of depression in the labour market. On April 28th, a new warrant was issued, adding the question of afforestation to the reference of the Royal Commission on Coast Erosion, originally limited to the sands of the sea shores or districts reclaimed from the sea, and dealing only with the unemployed. The first of the new series of witnesses was then called before the Commission, and then there dawned upon them a gigantic scheme, supported, financially speaking, as far as England was concerned, by evidence which was at least inconclusive. The Commissioners were directed to form a scheme for an experimental treatment of forestry in connection with unemployment, and they brought forward a coniferous scheme dealing with millions. His own belief was on the side of afforestation, but he confessed it had been somewhat shaken by the evidence of the Commission. The practical point now before the country which had to be considered was how far it could be shown that the planting of coniferous timber in England would pay the State. That the experiment of growing Douglas fir in Scotland was a promising one he made no doubt, but it had yet to be proved that it would pay the Crown to plant Scotch fir, spruce and larch in England, and he had formed an unfavourable opinion on that point from the recent Report of the Commission. With regard to the duty of the Crown to plant and keep up oak forests, he thought a strong *prima facie* case had been made out in favour of a national scheme of afforestation, because in all changes of science oak was likely to be necessary for many purposes, and the price of oak, though it might vary, would on the whole keep up. Oak took an average period of 120 years to mature, and only the Crown could afford to stand out of its money for that period. The question was affected in England by shooting; and even if the owner did not cut down all the timber that would make money at a given moment, thinning would be conducted upon the very opposite principles from those on which scientific forestry was based. He knew of a multi-millionaire who bought a magnificent series of English woods, and who proceeded to cut out of them the very trees which the woods were constructed to maintain, because the leaves of oaks of a particular size got in the way of the pheasants which he wanted to shoot. The *prima facie* case for maintaining oak forests was a strong one, but it meant good land upon which oak would grow in a period which would make it pay. A strong case had also been made out for ash, and probably other trees, and such things as osier growing; but the real question was as to the paying of coniferous timber under Crown management, with regard to which a very clear statement was needed before a new scheme was put before the country.

The paper read was—

AFFORESTATION AND TIMBER-PLANTING IN GREAT BRITAIN AND IRELAND.

By DR. J. NISBET.

During the last twenty-five years, four Committees and Commissions have been appointed by Government to deal with the question of Forestry in the United Kingdom, and with what is now, by rather a lax use of the term, spoken of as Afforestation, when timber-planting is really meant. In 1887, a Select Committee of the House of Commons recommended the establishment of a Forest Board and Forest Schools in England, Scotland and Ireland, and pointed out that, "apart from any immediate pecuniary benefits, there would be considerable social and economical advantages in an extensive system of planting in many parts of the kingdom, especially on the west side of Ireland and in the Highlands of Scotland. This subject is one of great importance, and well worthy of early consideration." No action was taken in the specific directions recommended by this Committee.

The second inquiry was made in 1902, when a Departmental Committee of the Board of Agriculture was appointed "to

inquire into and report as to the present position and future prospects of forestry, and the planting and management of woodlands in Great Britain." Reporting in 1903, they urged "immediate and effective provision for bringing systematised instruction within the reach of owners, agents, foresters, and woodmen . . . . as the first requisite in any project for the improvement of forestry," and recommended that "addditional facilities for instruction be afforded," and also that "assistance should be looked for from local authorities, societies, and individuals interested in forestry and technical education." And they also made another very important recommendation, that Government "should take steps to compile a statement of areas presumably suitable for afforestation in Great Britain." But though they took note of "the great area of waste land in these islands which might be afforested," they expressly refrained from advocating "any general scheme of State forests under present circumstances," . . . . and merely remarked that "Once adequate provision for training is made and the consequent improvement of our present woodlands becomes manifest, it will then be opportune to raise the subject either of loans or of State forests." The drawbacks to private planting were dealt with as "Minor Considerations;" and while the Committee were not prepared to make any recommendation regarding the incidence of local rates on plantations and the assessed valuation of woodlands, they thought that the claims for "extraordinary traffic" made by local authorities against timber merchants (and therefore ultimately paid by the timber-grower) were unjust and "unreasonable;" that the estate duties needed "immediate revision" as being "peculiarly unfair to the poorer districts," because "the pressure of such a death duty on timber must both act as a bar to afforestation in districts most needing it, and compel the realisation of immature timber, thus preventing the practice of sound forestry;" that security was needed against fires from railway sparks (since very inadequately provided up to a maximum compensation of £100 under the Railway Fires Act, 1905); and that "in the public interest the owner of plantations, who himself keeps down ground-game, should have the right to recover compensation for damage caused by hares and rabbits from adjoining property," so ruinous are these to systematic forestry and natural regeneration.

Very little action was taken upon this report. Many of the most important recommendations have been tacitly ignored, and especially that recommending the detailed inspection and scheduling of land suitable for profitable planting, which must of course be a step taken before any practical scheme of very extensive planting can be properly considered. By not carrying out the recommendations of the Committees of 1887 and 1902 much valuable time has been lost.

The third inquiry was that which took place when, in October, 1907, a Committee was appointed by the Department of Agriculture in Ireland to advise regarding an extensive scheme of forestry operations. Previous to this, however, while the Land Purchase Act of 1904 was under consideration, certain preliminary inquiries had been made as to the extent of waste and poor land which might probably be plantable with a reasonable prospect of direct profit, and the late Mr. Parnell's estate (Avondale, co. Wicklow) had been acquired in 1903 and equipped as a school for the training of practical foresters. In April, 1908, this Committee's report was issued. It is by far the most businesslike and practical afforestation and timber-planting scheme that has as yet been suggested for any of the four countries forming the United Kingdom. It recommended the acquisition of sufficient land (including some of the existing 300,000 acres of woodland) to provide for the formation of about 700,000 acres of woods and plantations, of which about 200,000 acres or more should be State forests in large blocks, while about 500,000 acres of smaller areas should be under County Councils or in private ownership. The weakest point in this scheme is, it seems to me, that it is not intended to confine planting operations to waste land and really poor grazing tracts worth only about a shilling an acre, but it recommends the afforestation of grazing land worth about 3s. 6d. per acre on the average, and usually capable of improvement. Anyhow, what is of vast practical importance, it very plainly indicates how, in the Committee's opinion, the money for carrying out this Irish afforestation scheme should be obtained. These proposals are still under consideration, though nearly a year has gone by without any pronouncement having as yet been made on the subject by Government.

The fourth and last inquiry was that instituted, after the Association of Municipal Corporations had (in 1907) pressed upon the notice of Government "its opinion that the time has

now arrived when the question of afforestation should be seriously considered," through the enlargement of the Royal Commission on Coast Erosion to report whether "it is desirable to make an experiment in afforestation as a means of increasing employment during periods of depression in the labour market, and, if so, by what authority, and under what conditions, such experiments should be conducted." Its report, submitted on January 4th, 1909, went far beyond the terms of reference as regards "an experiment in afforestation," and recommended the afforestation and planting of 9,000,000 acres, mostly grazing land at present, within the next 60 years, at a rate of 150,000 acres a year, and at a cost of £13 6s. 8d. per acre, £6 13s. 4d. being for the freehold and £6 13s. 4d. for the expenses of afforestation, or £2,000,000 annually—though it also outlined a smaller scheme for afforesting and planting 75,000 acres annually at a total cost of £1,000,000 a year. With regard to the question of afforestation as providing suitable work for the unemployed, the Commission has reported that "They have no hesitation in asserting that there are in the United Kingdom at any time, and especially in winter, thousands of men out of work for longer or shorter periods, who are quite ready and able to perform this or the higher class of labour." Here, however, their opinion is diametrically opposed to that of the Irish Forestry Committee, who were unanimous in stating that afforestation would not prove a direct remedy for the chronic state of unemployment from which Ireland has for years been suffering, though they pointed out that any extensive scheme of planting must indirectly help to ameliorate the condition of the working-classes. The exact terms in which this clear Irish statement was made are as follows:—

"The question of promoting forestry as one of the means of dealing with what is called the problem of unemployment, having been brought to our notice, we think it right to state our opinion on this question. It is, emphatically, that forestry cannot be considered as a specific for curing the evil which is commonly understood when this problem is spoken of, that of the chronic disemployment, especially in large cities, of large numbers of people belonging to different trades or callings. That the promotion of forestry on an adequate scale will provide a great deal of employment is unquestionable, and that is one of its principal advantages to a country. But such employment would be employment naturally forthcoming from the plantations and woods for the agricultural population in their vicinity, and it would be employment for an industrial population, more or less rural, forthcoming from the industries and commerce which may be developed in connection with the conversion and handling of the forest produce. This sort of employment cannot be provided on a large scale at once. It must be developed with steadiness and system, and above all it must be on sound economic lines."

Our planting season is from autumn to spring; and while the formation, tending, and harvesting of timber-crops will increase the amount of employment given to the rural population, it seems hardly reasonable to expect that planting-work on wind-swept waste lands in autumn and spring can be suitable for the elderly, the weakly, and the least skilful and energetic, who must always be the first to be thrown out of work, and the last to become re-employed in our large industrial centres. But as a practical commentary on what the second city in the British Isles thinks of this remedy for the unemployed it is noteworthy that on February 23rd, 1909, the Glasgow Distress Committee resolved that it should *not* be represented at any interview with the Secretary for Scotland—which deputation was received last Monday, March 22nd, two days ago—regarding a national scheme of afforestation.

On the average, a 60-year old wood should yield about 100 tons weight of timber per acre; and the felling, logging, transport, conversion and distribution of woodland produce will, of course, add directly and largely to the total amount of wages that would then be payable to labourers and workmen in this country, in place of being sent to foreign countries, as is at present the case. Indeed, there is hardly any branch of industry which would not benefit largely by our having extensive woodlands, and this obvious advantage is surely great enough to commend rational proposals for timber planting to our national business instincts.

The Royal Commission's vast scheme of afforestation is supported by financial calculations showing that timber-planting will prove a very profitable investment for the nation eighty years hence. These actuarial calculations have no practical value, for they deal with conditions and timber-crops which do not exist. They are little better than the usual prospectuses issued by vendors of concessions when floating speculative companies. If such calculations based upon vague data always came true there would never be insolvent joint stock companies or bankrupt tradesmen, for reasonable business men only embark on

ventures that give fair promise of being profitable; and the nation will be unwise to risk an investment of either one or two millions every year for the next sixty years merely upon the hope of having very profitable money returns from eighty years hence onwards. It is indisputable that timber-planting is desirable to the utmost extent possible; but a great national scheme of afforestation should rest upon a broader and surer economic basis than subtle calculations (based mainly upon German data as to yield) that may easily be partially upset by heavy gales like those which wrecked the Tay Bridge, at Christmas, 1879, blew down millions of trees in Perthshire, in November, 1893, and did a vast amount of damage to woodlands in Ireland, in February, 1903—to say nothing of epidemic fungous diseases, such as the Larch canker, to the development and spread of which our comparatively mild, humid and equable climate is even more favourable than it undoubtedly also is to the growth of timber trees. Unquestionably, extensive plantations would give work to the rural population, and would bring great and almost immediate advantage to agriculture, especially to stock-raising, on wind-swept moors and hillsides; and ultimately the handling of the timber-crops and the timber itself, as a raw material for many industries, would circulate a very large total amount of money throughout the British Isles. It is on these firmer economic realities, rather than on unreliable forecasts and calculations, that any national scheme of afforestation must be based; and there can be little doubt that with the world's constantly increasing demand for wood, and constantly decreasing supply, well-formed plantations ought to prove a sound and remunerative investment if made prudently, and on a large scale.

The Commission has quoted many examples of profitable forestry in Britain; but mention of dead failures seems to have been deliberately suppressed. What of the Knockboy plantations in Connemara, where £10,000 were lost utterly on a site upon which the planting experiment was foredoomed to failure?

It may be urged that these calculations as to profit eighty years hence are based upon German data; but this presumes that German physical and economic conditions are analogous to our own, which is *not* the case. In Germany most of the vast woodland tracts have been under forest from time immemorial, have been under prudent management for generations, and have for at least during the last sixty or seventy years been worked with a scientific skill that we cannot hope to attain at once. Moreover, to plant bare, denuded waste lands with timber is quite a different matter from merely improving the management of great natural forests. To create new woodlands on bare, impoverished, and often water-logged land involves a great capital outlay, with all the risks and disappointments attendant on a vast scheme of creating supplies of raw material for the establishment of new industries in the British Isles. And if German results be appealed to for guidance in this particular business, then it is not to Saxony that one should look, but to Prussia, which has much greater resemblance to Britain so far as regards its northern climate, its partial seaboard, and its great stretches of poor moor and heatherland, with a scanty population—although Prussia, too, has large areas of splendid spruce forests (Harz) and rich oak and beech (Solling, Ems, Weser, &c.), During the four quinquennial periods from 1877 to 1896 the average net income per acre per annum for the Prussian State forests was 3·7, 4·1, 4·9, and 5·1 shillings; and though it is larger now than then, it does not necessarily follow that British plantations on waste lands and poor grazing tracts will either equal or surpass in net income the profit earned in Prussia from 12 to 17 years ago. But as the reclamation and planting of waste land has been going on in Prussia continuously for over 55 years, it would have been of special value to have had definite and unprejudiced evidence as to the actual material and monetary results now accruing from these plantations.

So far as their report shows, the Royal Commission does not appear to have attempted to obtain any information on this most important point. Certain data referring to afforestation and planting, I can give you now, however, which will of themselves prove most emphatically that the physical and economic conditions throughout the waste land tracts of Prussia are entirely different from those obtaining in our waste land areas and poor pastures. Between October 1st, 1904, and September 30th, 1907, the Prussian State Forest Department acquired by purchase 46,346 acres of waste land, and planted 33,998 acres with timber trees of various kinds, mostly conifers, at an average cost of 48s. per acre. But, besides that, village communes and corporations, and other bodies have likewise been carrying out planting operations, towards the expenditure on which

the State also makes a partial contribution. The Prussian Forest Department, to whose courtesy I owe these details, unfortunately did not state the cost of the land acquired; but the planting at £2 8s. per acre is very different from the average of £6 13s. 4d. an acre, which the Royal Commission considers necessary.

The serious position of Britain with regard to timber is perhaps hardly as yet realised generally. Apart from all other timber, in 1907 our imports of rough-hewn pitwood came to 2,627,209 loads, valued at £3,049,484, while those of wood-pulp came to 672,499 tons, valued at £3,312,347. These two items alone amounted to £6,361,831, and exceeded in value the similar imports of any previous year. To supply these demands alone, without making any provision for future increase with increasing population, would need the annual fall from about 3,000,000 acres of conifer and other woodlands—that is to say, an annual cut of about 60,000 acres of woods worked with a fifty years' rotation, or of 50,000 acres of woods worked on a sixty years' rotation. The satisfaction of the future demands for pitwood is, surely one of the most important matters connected with afforestation in the United Kingdom. It is probably only a question of time before the large pitwood imports from the French State forests near Bordeaux to Britain must fall off, owing to the increasing demand for and the decreasing supplies of suitable wood for the collieries in the interior of France. In coming years the supply of pitwood to British coal mines is likely to cost more; and whatever tends thus to raise the price of working coal must at the same time influence all our industries dependent on coal as part of their raw material for producing commercial articles. The wood-pulp industry (hardly existing in Britain, and only on foreign wood) is capable of enormous expansion, given sufficient supplies of softwood; and it is an industry that would spring up in rural districts wherever such raw material could be supplied in large enough quantities. In 1904 mechanical wood-pulp cost in Britain 85s. a ton, in 1908 it rose to 120s. In America its price has been trebled in the last ten years, and everywhere its value is bound to increase greatly in the near future. Pulpwood thus differs from pitwood, for even now fairly large supplies of wood that might well be used in coal mines have little or no value *in situ* owing to the cost of transport to the mining districts.

And last year, a year of great commercial depression, our imports of pitwood and wood-pulp were far larger than ever before, increasing respectively by £313,000 and £843,000, or £1,156,000 in all, over the previous highest record in 1907.

	Year.	Loads.	Value.
Hewn Pitprops or Pitwood	1906 ..	2,451,665 ..	£2,713,005
" "	1907 ..	2,627,209 ..	3,049,484
" "	1908 ..	3,041,440 ..	3,579,355

	Year.	Tons.	Value.
Woodpulp	1906 ..	606,811 ..	£2,915,209
"	1907 ..	672,499 ..	3,312,347
"	1908 ..	748,419 ..	3,625,803

	Year.	Value
Combined value of Pitwood and Woodpulp alone	1906 ..	£5,628,214
" " "	1907 ..	6,361,831
" " "	1908 ..	7,205,158

The total value of our wood and timber imports was £27,507,410 in 1906, £27,093,054 in 1907, and £24,306,059 in the depressed year of 1908. Of this total £18,534,958 in 1906, £17,146,823 in 1907, and £14,515,433 in 1908 were for wood "sawn or split, planed or dressed," and at least one-third of this amount represents wages paid to foreign workmen (in addition to the ordinary cost of extraction from the forests), a great part of which might be retained for our own industrial classes if we had the necessary raw material to operate upon.

If our waste lands and poor pastures are at all plantable with profit, it will be in coniferous and softwood crops for pitwood and pulp that the best returns must be sought. Such crops are the most likely to thrive on poor land, cost least to establish, and give the quickest returns. It may be safely taken that 3,000,000 acres of woodlands (chiefly conifer) are the minimum that should be provided either by the State on its own responsibility or in co-operation with County Councils and private landowners.

To carry out a vast scheme of afforestation, such as the 9,000,000 acres of planting which the Royal Commission recommends, three main points have to be taken into consideration :—

1. Money.
2. Land.
3. Labour and Supervision.

1. *Money.*—With regard to providing funds no suggestion whatever has been made. With an enormous deficit to face, the Treasury cannot possibly grant funds for such a vast

and not immediately profitable investment. Probably the only way in which money can be raised as required will be to form a "National Afforestation Fund" by issuing guaranteed $2\frac{3}{4}$ per cent. stock for the amount needed during each of the next sixty years while planting continues. But why not here look towards Prussia for light and guidance? Parts of the Grunewald Forest, near Berlin, have risen greatly in value, and portions of this are being sold, in order to buy big stretches of waste land for afforesting and planting. Now, the £561,000 a year at present being raked into the coffers of the Commissioners of Woods, Forests and Land Revenues of the Crown are mainly obtained from London house and office property; and as the hundred-year leases are now falling in, these most valuable properties can easily be sold to provide many millions of pounds sterling for the afforestation and planting of waste lands and poor pastures, if the Treasury approve and authorise such a course being taken.

2. *Land*.—The Commission estimated that 6,000,000 acres of suitable land are obtainable in Scotland, 2,500,000 acres in England and Wales, and at least 500,000 acres in Ireland, making 9,000,000 acres in all. But the land area of Scotland is only 19,069,770 acres, while that of Ireland is 20,327,947 acres; and to suppose that there is about twelve times as much plantable land in Scotland as in Ireland is incorrect, while it is equally wrong to imagine that nearly one-third of the total area of Scotland is plantable with profit. Over $3\frac{1}{2}$ million acres are above the 1,500 feet contour; and to assert that nearly two-fifths of all the rest is waste land or poor pasture plantable with profit must seem strange to those well acquainted with the Scottish hills and moors. Even in the most favoured localities timber-growing can seldom prove profitable as high as 1,000 feet; and if all the land above that elevation be subtracted, then it will probably be found that 6,000,000 acres represent quite an irrational proportion of the remaining land less suitable for agricultural occupation than for forestry. And as most of the hill land below 1,000 to 1,200 feet forms winter pasture for sheep stocks, if that be taken for afforestation the whole grazing industry will become dislocated, and the whole of the Highland sheep-farmers will be in a state of political revolt.

But even more amazing than the extent of land considered suitable for profitable planting is the manner in which it is proposed to be acquired. No attempt is to be made to assist and encourage landowners willing to plant, and this is a very weak point in the scheme; because, although *under existing conditions and laws* the State is the only landowner that can afford to create large compact blocks of woodland without desiring quick returns, yet a vast State monopoly of timber-growing can only be justified after the failure of fair attempts at assisting and encouraging private landowners by means of money loans and legislative amendments (*e.g.*, as to settled estates, law of entail, rating and valuation, succession and estate duty, lands improvement, railway fires, damage by ground game, railway and road charges, and various other matters effecting land, crops and finance). Under the existing conditions, my own personal opinion (stated on page 93 of vol. i., "The Forester," in 1905) coincides with that expressed by the Commission, and is as follows:—

"The necessity for State assistance is a chronic drawback to planting for profit. Early in the last century this was just as much the case as it now is. Even then, although all the timber, bark, and small material from the copse-woods was easily sold at good prices, want of funds prevented extensive planting of waste lands. 'Such lands, it must be owned, are sufficiently abundant, but the great expense and slow returns of planting are inconvenient to the majority of land proprietors. . . . The expense of planting is immediate and certain, the profit distant and precarious.' (*Quarterly Review*, 1813, vol. x. p. 9.)

"This is precisely what the recent Committee on Forestry, 1902, has reiterated. The main drawback to planting is, and has always been, and probably always will be, want of funds; all the other obstacles can far more easily be removed.

"But even if substantial inducements could be offered by Government to private landowners, it would not necessarily follow that the plantations thereafter formed would be managed upon more business-like principles than are the existing woods and plantations. The State is the only possible landowner that can be expected to create large compact blocks of woodlands in the United Kingdom, to be managed on sylvicultural principles, with the twofold object of providing supplies of timber in the future and of fostering and encouraging rural and wood-consuming industries. If this be a duty at all, it is the duty of the State, and not of the private landowner. The State is the only landowner that never dies nor is called upon to pay estate and succession duty, and it is the only landowner that can make large investments without being compelled to desire quick returns in the shape of income; hence the State is the only landowner that can be

sure of remaining free from the temptation to thin timber-crops at an early age and to a great extent—or, in short, that can afford to grow the best classes of timber upon rational principles."

Private timber-planting has hitherto failed from want of funds, oppressive legislation and financial burdens, want of money, want of systematic management, and overpreservation of game (especially ground game). But these drawbacks can be remedied; and till private landowners have been found unwilling to agree to reasonable proposals when made by Government there seems no justification for the compulsory expropriation of nearly one-third of the whole of Scotland, as thus recommended by the Commission:—

"It will be necessary at an early stage, for the State to acquire suitable land, and at once the alternatives arise of acquisition by negociation or by compulsion . . . we, therefore, recommend that compulsory powers be obtained by legislative enactment, and that a general survey should be made with a view to ascertaining what lands are available for the purposes of State afforestation. These lands should be purchased from time to time as required, the owner receiving in compensation their full value in all the circumstances of each particular case, following the precedent of the Small Holdings Act, 1907, so far as it is applicable. Compensation should be paid also to sitting tenants."

During the last five months my professional advice has been asked regarding timber-planting on several Argyllshire estates, and in each case I have advised the landowner, before committing himself to any such investment, to ascertain from Government what financial and other assistance and encouragement they are prepared to give in this direction. But the recommendation of the Commission is dead against any such assistance:—"In no circumstances, do your Commissioners suggest that the State should be expected to finance schemes of private afforestation, by way of loan or otherwise. The security would not, in their opinion, in such cases, be of a sufficiently substantial kind to warrant such action."

Here again, however, on this most important point, the Irish Forestry Committee gave a different, and a far more common-sense recommendation in the following words:—

"For the . . . . larger landed proprietor, the inducement must be of a nature that would relieve him to some extent from the immediate lock-up of capital incurred in planting operations, and at the same time provide a guarantee that the outlay would prove, so far as the holding is concerned, a sound investment. Easy loans, with deferred interest, absolute security of tenure in respect of the lands coming under the scheme, and free advice in all branches of forestry, are the chief means which seem to us best calculated to meet this case."

When it seems to suit their purposes, the Commission quote German and French forestry statistics, though they ignore other very relevant data. In both France and Germany the great bulk of the woodlands is in private or corporate ownership:—

	France. Acres.	Germany. Acres
Woodland area	23,400,000 ..	34,730,000
Percentage of woodlands owned by:—		
	Per cent.	Per cent.
State and Crown	11 ..	33
Private landowners ..	66½ ..	47½
Church lands & other endowments, municipalities, village communals, and corporations	22½ ..	19½

Although both of these countries are devoting large sums annually to the acquisition and planting of waste lands, yet private planting is encouraged, and compulsory acquisition is only resorted to in extreme cases (*e.g.*, mountain-planting in the Pyrenees); and even then the planted land can be subsequently re-acquired by the original owner at its actual cost after the *reboisement* has been carried out. Why should not reasonable endeavours be made in this direction in Great Britain? The Irish Forestry Committee's Report of April, 1908, is much more commonsense in this respect when it advocates the planting of 200,000 acres of State forests in large blocks, and of 500,000 acres by County Councils and private landowners in smaller blocks. And, further, the class of land acquired for planting should certainly not be that having a freehold value anything like so high as £6 13s. 4d. an acre, for many thousands of acres can easily be acquired at about £2 an acre, plus sheep acclimatisation value of about other 5s. per acre, or £2 5s. in all.

3. *Labour and Supervision.*—Even supposing that the £2,000,000 a year recommended by the Commission to be spent on acquiring and planting land could be provided, it could not be economically spent at present owing to the Committees' recommendations in 1887 and 1902 not having been acted on. Within the last five years small schools for practical foresters have been formed at the Forest of Dean for England and Wales, and at Avondale (co. Wicklow), for Ireland; but as yet no such school has been established in Scot-

land, and the only places where more or less systematic outdoor instruction in woodland work is there given are private estates such as Scone and Murthly, in Perthshire. In this respect Scotland is deeply indebted to landowners like the Earl of Mansfield, Mr. Stewart Fotheringham, Mr. Munro Ferguson, and some others, who have done much to advance the education of forest apprentices. But for a great national scheme of planting a large number of well-trained practical foresters will be required, and such training has not yet been organised to meet the demand that would then be made for men of this class. And the labour difficulty will be enormous. Already in Argyllshire, planters and nursery hands receive 3s. 4d. a day, and are exceedingly scarce. Special arrangements would have to be made for planting colonies, while the men engaged would need extra close supervision. No class of work can more readily lend itself to scamping than planting; and if the planting be badly done, then the Commission's sanguine financial forecast becomes utterly impossible of realisation.

Nothing is yet known as to the intentions of Government with regard to either the Irish scheme, or that recommended for Great Britain. In the House of Commons, on February 17th, 1909, Mr. Burns, President of the Local Government Board, said concerning the latter that—

"One of the reasons why the Government did not include afforestation in the King's Speech was, that the Report was only just submitted to them, and was to be read in connection with the Report of the Poor Law. It was a subject that did not require legislation of an elaborate sort, but it did require a great deal of money, and the Government were not justified in including any proposals in the King's Speech in regard to it until they knew what money the Chancellor of the Exchequer would be able to place at their disposal. The thing, however, had passed from an experimental stage, and the Government were seriously considering it with a view to action."

This last official statement was immediately contradicted by Mr. Munro-Ferguson, who maintained that—

"The right hon. gentleman was entirely wrong in telling the House that afforestation had passed beyond the experimental stage. There had been a few experiments by a few scattered landowners, but the State itself had done absolutely nothing. The State had not only kept its own forests in a most disgraceful state, but it had failed, in spite of every kind of pressure, to provide any training whatever either for its own servants or those of the private adventurer. We must at least have two Schools of Forestry, and the Government would want about £100,000 to start with."

Now, all that has been done experimentally by Government, was thus summed up by Mr. Pease, Junior Lord of the Treasury, on February 11th, 1908:—

"The amount spent by the Commissioners on Woods and Forests during the last ten years, in England and Wales, on afforestation, by which term is meant planting new areas, not previously under timber, as distinguished from re-planting old woods, is about £5,000. The cost of land, in England and Wales, bought during the same period for afforestation, is about £1,200. There has been no expenditure on planting new areas in Scotland or Ireland, but £25,000 has recently been spent in buying land in Scotland for afforestation."

Since then no planting has yet been done on this Crown estate of Inverliever, Argyllshire (bought for £25,000); but planting is to begin this autumn, and only 150 acres a year are to be planted for the next twelve years.

And Mr. Burns's statement, that anything like a great national scheme of afforestation is "a subject that did not require legislation of an elaborate sort," is quite wrong, and simply shows that apparently Government have as yet no proper idea of this subject at all. Very numerous legislative amendments will have to be made in existing Acts (*e.g.*, rights of owner in possession under law of entail in Scotland, and various other Acts previously referred to), which are bound to have far-reaching consequences. And the proposal to expropriate for afforestation about one-third of the land of Scotland, must either result in the fall of any Government that is foolish enough to propose it, or, if carried, will mark the first and the greatest step towards an era of Socialism in Britain. And if land is to be forcibly nationalised for forestry, then the ancient royal forests must be the first areas dealt with by the State and expropriated from the Crown.

With both the Irish Forestry Committee's and the Royal Commission's contradictory reports before them, it may probably be expected that the Government will desire more detailed information regarding separate schemes for England, Scotland, and Wales. The best way of formulating really sound and practicable schemes is, perhaps, first of all to determine to what Department of Government afforestation work in each country shall be entrusted; and then in each of these three countries to appoint a National Forestry Board or Afforestation Committee, consisting of representatives

of (1) Government; (2) County Councils; and (3) Landowners, Land Agents and Sheep Farmers, to consider and report, whilst simultaneously collecting reliable local data, county by county, regarding the amount of plantable land probably obtainable on reasonable terms, and the existing conditions with regard to the supply of labour suitable for planting-work. And if, as should certainly be the case, it be desired to assist and encourage landowners to plant (*e.g.*, by granting loans at 3 per cent. under proper conditions as to security and systematic planting and management, and by lightening the burdens on land put under timber), then such boards or committees will have many knotty points to consider. Thus, with regard to rating, it will not be sufficient merely to exempt the land from rates till the timber-crops give good returns, for that would mean throwing an additional burden on the whole of the rest of the rateable land in the county; and the only way of removing a difficulty of this sort will be for Government to give an annual bonus equal to the amount of rate paid until returns are obtainable from the timber-crop.

The Royal Commission has not given sufficient consideration to the great practical difficulties connected with hill planting on a large scale. Probably they had no evidence before them as to the immense jungle of long grasses and weeds that springs up when the sheep are taken off and the area is fenced and planted, and late frosts in spring have done much damage in many recent plantations.

Confining my remarks merely to Argyllshire, which contains much suitable land, an enormous amount of drainage will be needed, for in many parts the average rainfall is near or over 100 inches. And throughout the greater part of Scotland landowners, factors, foresters, and labourers will all have to be educated up to the point of seeing how pernicious on stiff or peaty soil is the now long-practiced, irrational system of notch-planting, unsuitable for any except a very light soil, though it is certainly the cheapest method of planting. "Profitable crops have been raised thus in the past, and why not now?" they ask; or else unfavourable criticism of this method is met with a cold and rather contemptuous silence. It will take years to educate the local labour up to this point, and it is hardly conceivable that casual labour will meanwhile be obtainable either in sufficient quantity or with the necessary skill for this particular kind of out-door work.

Sometimes, also, the objection has been raised that extensive planting would increase the rainfall, impair the climate, and affect the national character. Such fears are unfounded. It is not on local and interior conditions that our damp insular climate is mainly dependent, and by which it is regulated, because the chief factors are the Great Atlantic Gulf Stream to which our mild, equable climate is due, and the moist Atlantic winds coming from the south-west, which prevail throughout the greater part of the year. Large woodland tracts would hardly, if at all, increase the rainfall perceptibly, though their influence would certainly tend to increase the relative humidity of the atmosphere in the vicinity of the forests; but any drawback which might possibly thus arise (and this it would be difficult to estimate beforehand) would certainly be far outweighed by the additional shelter they would provide for grazing stock, and by the water-storing capacity of the woodlands and the immunity against inundations that this tends to provide. The heaviest annual rainfall in the British Isles is in Cumberland (Styhead Pass), but is the character of Cumberland men therefore impaired on that account? Or has that in the slightest degree dulled their natural shrewdness or their business instincts and capacity?

In conclusion, it has often been asserted that extensive planting would interfere greatly with sport. If the bare Scottish deer forests were covered with woods the character of the sport would certainly be changed; but it is far more likely that the sport would be improved than deteriorated thereby. Any closer consideration of this particular point, however, would only unnecessarily extend this already long paper.

DISCUSSION.

Sir HERBERT MAXWELL, in opening the discussion, said he had been much impressed by the view taken by the author of the possibilities of an industry which was essential to the future of all other great British industries. None of the principal industries of this country could subsist without an ample and reasonably cheap supply of timber. He had taken out the figures of the timber consumption in this country and the rise in price during the twenty years from 1886 to 1905, and he found that while the import had risen 90 per cent., the average price of timber had risen during that period 22 per cent. He thought it was a very grave consideration for the manufacturers of this country how far any of the industries could face with any confidence a further rise of 22 per cent. during the next 20 years: it would be almost prohibitive. The foreign

supply was not likely to get larger, the accessible forests in the world were disappearing, and the price was rising steadily. During the more than 20 years he had been a railway director, the companies had had to pay more heavily each year for their timber supplies. It might be said that the price of British timber had diminished, but he thought there were conditions affecting the home timber trade which did not give quite fair results. In the first place, there was the very irregular supply, for which the producers were to blame. The author had criticised very severely the findings of the Royal Commission. Personally he agreed with a good deal that had been said, especially that it would be ridiculous to expect to rear profitable woodlands above the thousand feet level in Scotland; but he did not agree with the author that the British Isles were more liable to gales than the Continent. This country suffered more from them not only because of the way in which the woodlands had been planted, but because of the drastic over-thinning to which they had been subjected. When the Romans landed in this country 2,000 years ago, everything under the thousand feet level was dense forest from sea to sea, and there was no meteorological reason why, except on the exposed seaboard, that should not be the case again. One point in the Royal Commission's Report was worthy of special attention, the social point. It was brought out in Dr. Schlick's evidence how closely the forestry industry was associated with small holdings in Bavaria and Bohemia, the men who worked on their small holdings of from one to ten acres during the summer, finding constant employment in the forest during the autumn. The very large proportion of crofters who had claimed and obtained pensions in the West Highlands under the Old Age Pensions Act on the ground of the inadequacy of their living, showed what a low level of subsistence was attained by people dependent only upon arable land in very small portions. Apart from the economic consideration of the question, of which he did not take so despondent a view as the author, it was worth the attention of the rulers of this country, not to put people back on the land, which was a hopeless business, but to keep them from leaving the land, by providing, in forestry, a source of winter employment. As the forest grew to maturity, many other subsidiary industries would also grow up. It was in that direction they most hopefully looked, not only for the success of the subdivision of land into small holdings, but also for maintaining a vigorous and healthy population upon the land.

Mr. H. J. Elwes, F.R.S., said the paper was practically a criticism of the Report of the Royal Commission. He could not conceive how men could have been appointed by the Government to enquire into a subject, who carefully avoided calling a very large proportion of witnesses who could have told them what they wanted to know. As a matter of fact, the Commission was appointed for a different purpose. It would have been supposed that whatever might be said against the land-owners of Great Britain, at least they or their agents could have given the Commission more practical knowledge on that particular question than anybody else. It was ridiculous to enquire into such a subject without going to the men who really did know. Speaking from the point of view of the English landowner, he agreed with almost everything the Chairman said in his opening remarks, because it was necessary not to mix up the two questions of unemployment and forestry, which had absolutely no connection. He had employed agricultural labourers who were out of work in the winter for afforestation purposes, and it was the most costly and unsuccessful experiment he had ever made. The point the Commission entirely overlooked was, that where unemployment was rife there was no land capable of being acquired at a price, or which was suitable in its character to grow profitable trees. Trees of a sort could be grown on almost any land, but it was impossible to grow trees that would compete with imported foreign timber on the land the Government expected to buy at £2 an acre. In the Appendix to the Report of the Commission, the six gentlemen who were sent out into six different districts of England to search for land, stated that they could not find any. It was impossible to find in those reports a single instance of an area of 1,000 acres in a block which they were able to select as likely to prove an economic experiment for the Government to undertake. He was not referring to Scotland, Ireland, or Wales, where there were many thousands or millions of acres available if the people would only give them up. The whole bottom was really knocked out of the Report. In the first place the premises in the financial part were rotten, because they were based upon conditions derived entirely from Germany, where neither the social, climatic, geological, nor any of the other conditions applied. A good deal of private property would be found in Germany and France which had been just as badly managed as English woodlands for precisely the same reason, namely, that it paid better to have lots of game than fine trees. Any practical valuer or land agent would give the opinion that it was ten times easier to sell a good sporting property, with a lot of ornamental and artistic timber upon it, than it would be to get a single bid for the most perfect 10,000 acres of German pine forests that ever existed. It was impossible to pretend that this country could ever compete with the North of Europe in the production of timber. Wood-pulp might be made if the water-power was available, but it could not be found close to sufficiently large areas of land where the pulp could be grown; and, even if it could, it would be found that, with cheap foreign labour, pulp-wood or pit-wood would be imported into this country at a cheaper price than it could be grown 30 or 40 miles off from the place in England where it was to be used. He could not personally compete with pit-wood imported from Bordeaux, even in a district only

20 miles distant from his land. English plantations could not profitably be extended on poor waste land that could be bought at £2 an acre. Much more good would be done by growing hard woods, such as elm, ash, and oak, on better land and in places where they were wanted, than by trying to cover a lot of barren mountains, in the very few parts of England where such existed, with timber of a cheap class which could never be grown at a profit. If, however, inducements were given to English land owners to grow timber, they could grow it as well as the Germans, but they must receive fair play, and it was impossible to say that was given to them with the present system of taxation and rating on woodlands. It was necessary also to have fair railway rates, there being nothing so grossly unfair in England as the preferential railway rates which were given to foreign timber. As long as such unfair conditions existed it would be impossible to have anything like the expansion of plantations that he would like to see. By the Report of the Royal Commission this country was asked to raise funds for the benefit largely of Scotland. Supposing that even one-tenth part of the recommendations of the Commission were carried out, the market would be entirely destroyed for all private growers of timber in England. If the timber merchants of England knew that the Government must cut down the timber on their land and sell it, they would offer a ridiculous price for it, because the Chancellor of the Exchequer would not be able to wait and hold back the timber for a favourable market. Although he admitted that the price of timber was likely to rise, he thought it would not do so as much as some people expected. It was time the true facts of the case were brought to the notice of the Legislature, before they landed the country in such a gigantic gamble as the scheme of the Royal Commission proposed.

Prof. J. B. FARMER, F.R.S., emphasised the necessity of an improvement in forestry education in this country, which, he contended, was lamentably behind what it ought to be. He had been glad to hear the author make such strong protests against purely theoretical teaching, having always felt that demonstration areas were of supreme importance in this country, because of the knowledge of local conditions which was thereby obtained. He did not depreciate the value of the instruction imparted at the great forestry schools such as Munich, but the conditions there were totally different from those obtaining in this country, where it was necessary to provide areas in which foresters could be definitely trained under the conditions in which they would have to work. Forestry must be treated as a kind of intensive cultivation, and there ought to be a school of forestry in this country on an experimental scale, which did work similar to that which Rothamsted carried out for agriculture. There was a school at Oxford, and others had been begun at Cambridge, and elsewhere, but through the lack of experimental stations, they were not nearly so efficient as they might be.

The CHAIRMAN (The Right Hon. Sir Charles Wentworth Dilke) in proposing a cordial vote of thanks to the author for his exceedingly interesting paper, regretted that someone had not attended the meeting to represent more strongly than had been the case those people who were desirous of trying a large afforestation scheme in England, because it would be admitted that it would be impossible to make it a national scheme if it was to apply to Scotland and Ireland only; the English case would have to be faced. He contended that coniferous timber could not be grown to pay in England, even larch. It was impossible to find any but exceptional places in England where either larch or spruce could be grown without draining the ground. The land always appeared to be either subject to occasional droughts, during which the trees died, or if it was fairly watered ground the odds were that the roots got into peaty stuff, so that moss was produced upon them, and that trees could not therefore be produced to pay. Reference had been made to the Dean Forest School, which was under very good control, and if only people would begin to draw foresters from it, it would soon spread. This country had been horribly backward up to the present time, and it was only within the last few years that a school of assistant woodmen had been produced who could tell the difference between Pacific Slope Douglas and the Colorado Douglas, two trees which were botanically the same, but which for the purpose of growing timber were as different as chalk from cheese. With regard to demonstration areas, he believed that for oak forest, there was nothing so good in England as the High Meadow Woods, under Dean Forest management, which were by far the best oak woods in this country. On the other hand, such a demonstration area should include a portion showing the worst possible growth of oak, and that was also in existence in what were known as the orchards, the oak trees in which looked like small apple trees of very ancient date. As a result of the enquiry previous to the recent Royal Commission, Alice Holt was produced as a demonstration area, though also an example of what to avoid and not to follow. The Crown forests were originally planted for the supply of oak timber to the Navy, and it had always been frankly stated that the question of profit was not seriously considered, it being merged in the question of the necessity of providing for national defence. In recent times there had been a great improvement. The only large oak wood in England was Dean Forest, which contained—including neighbouring Crown freehold—19,000 acres of unbroken oak forest. There was no doubt that the growth of oak would pay the Crown, and so, perhaps, would ash and other timbers. He had particularly wished to hear something with regard to Douglas fir, because the enormous bulk of the evidence of the last Royal Commission relied mainly upon that timber; but there was nothing

like a proof of success, except in a few cases in Scotland.

Mr. Elwes, interposing, said he gave very complete statistics, in his book, with regard to Douglas fir, at four English places.

The Chairman, continuing, said that one of the questions on which information was required was, what chance there was of growing pulp timber at a profit in this country. A good deal of the case of the Royal Commission was based on the assumption that the production of pulp from other countries would so greatly fall off, that pulp would fetch a price which would enable it to be grown here. Of that he was profoundly sceptical. With regard to pit-prop timber, it was not all drawn from a single kind of tree or country. Different kinds of pit-props were required, some holding tight as long as possible, and others yielding gradually to pressure, until the whole of the vacant space was filled by the weight of the rock. The production of the French forests was not declining, but, on the contrary, increasing and keeping pace with the demand. The pit-props obtained from Western France were only in the nature of a by-product, turpentines and essences first of all being extracted from the tree. Again, there was an infinite supply of wood of the same inferior kind entirely untouched in Corsica and other places on the borders of the Mediterranean. He had recently discussed the question of pulp timber with experts, and many denied that a permanent falling off in it was likely. It was necessary to get some facts with regard to the possibility of growing pulp profitably in this country. Anybody could grow spruce for Christmas trees, but when they passed an age at which a magnificent profit could be made on them, if a market could be found, English spruce was apt to be conspicuous by its inferiority. People had not learned to grow spruce in this country, and that tree was probably not suitable to it. The Corsican pine had not been mentioned. This tree in inferior soil both in England and in Belgium, on sand, yielded good results. It was a prey to the attacks of the pine-shoot beetle, although less than was Scotch. As a matter of fact, all failures were excluded from the volume of evidence, and the question of the ravages of the pine-shoot beetle was conspicuous by its absence. Such insect pests could be stamped out, but, as with drainage to prevent mossiness in spruce, the triumph of man over Nature was too costly for the financial scheme. Neither the Government nor the counties could be expected to go into speculations of the kind suggested unless a fair financial statement was produced, showing that they had at least some chance of getting their money back.

The resolution of thanks was then put, and carried unanimously.

Dr. Nisbet, in reply, said the discussion had proved more clearly than before that what was required was not a general scheme, but that each country must consider a scheme for itself. Evidence had been adduced showing that England was not at all suited for the conditions that had evidently been in the mind of the Royal Commission. There was no doubt that a far better class of land was required to grow oak than waste land and poor pasture; but even on such lands in Scotland, when once woodlands were well established, ash and other hardwoods grew freely, and they were much more likely to pay in those parts than if they were planted on bare hill sides. With regard to the question of pit-props, if the price of wood went up it must necessarily affect all the industries of the country. That was particularly the case with pitwood, because coal was the raw material for nearly every one of the British industries; and whatever tended to force up the cost of working coal must have a very bad effect on British trade and commerce. It was an open question whether greater damage would be done by gales in the British Isles than on the Continent. This country did not possess such extensive forests, so that it was impossible to say from experience what effect would be produced. The climate of this country was certainly more favourable to the growth of timber trees than the Continental climate; but it must not be forgotten, also, that its mild equitable climate, with the long autumn and spring, was at the same time more favourable for the fructification of fungi, and that late and early frosts do more damage here than on the Continent. Unfortunately, the Douglas fir in Scotland had, in a good many instances, been attacked by a rather serious fungus-disease, which might possibly become of the same importance as the larch canker. Menzies spruce was also not exempt from the disease, and it would be a great misfortune if large plantations were made without proper experience being acquired by experiment as to the proper soils, situations, and methods of growing those valuable timber trees. Whatever might be the case in England, spruce and silver fir grow well in Scotland, and up till 60 or 70 years of age would probably give good returns for pulp-wood. Spruce, undoubtedly, grew better in the north and west of Scotland than anywhere in England. With regard to what Sir Herbert Maxwell said of the great advantage that would be obtained by keeping the people on the land, even in Germany attention had been drawn in the Reichstag within the last three weeks to the growing difficulty of the problem of retaining men on the land, even in the forest areas, where constant work was obtainable. The men had begun to show a desire to drift towards the towns, but extensive forests would do as much as anything to counteract that desire. It seemed to him that England, Scotland and Wales ought to appoint separate Committees, similar to the Irish Forestry Committee, to deal with the local conditions, and that far broader views with regard to the ownership and management of new woodlands should be taken than was the case in the Royal Commission's report.

HOME INDUSTRIES.

Miners and the New Act.—The Miners' (Eight Hours) Act which comes into force (outside Northumberland and Durham) on the 1st July, will revolutionise the existing system and necessitate readjustment of working hours. The Executive of the Miners' Federation of Great Britain has decided to call a general conference of all the mining districts in Great Britain to consider the position. The difficulties in the way of the men are intensified by the varying conditions which prevail in the numerous coalfields. In Scotland, Fife and some of the other districts already work an eight hours day, and in Nottinghamshire and Staffordshire eight hours has been the rule at many collieries, so that the adjustment to the new conditions will be comparatively easy. But it will be different elsewhere. In South Wales it has been the custom to work four long days of ten hours and two short days of seven hours a week. In Lancashire a ten hours day has been worked at a good many pits. In Northumberland and Durham it has been the practice to work the pits with two sets of coal-hewers working for seven hours and one set of labourers and boys working from nine to ten hours. Obviously the adjustments of working-hours must be separately undertaken in each coalfield even though the national conference may agree to a general policy to govern the procedure to be followed throughout the country. The negotiations will have to be very tactfully conducted if matters are to be settled without serious friction. The English Conciliation Board agreement contains a clause which empowers either party to give notice to terminate the agreement, but no notice has been given. The South Wales agreement contains no such clause, but the coalowners have obtained an opinion from counsel that the Act ends the agreement, while another counsel has advised the miners that it does not. With the exception of the small coal field in the Forest of Dean, and some pits in South Staffordshire, all the mining districts in Great Britain are members of the Federation, and it is hoped by taking concerted action to secure for the men the full advantage of the Act without any serious loss in wage-earning capacity.

Labour Exchanges.—A special Conference of Trade Union delegates, convened by the Parliamentary Committee of the Trades Union Congress, met last week to consider the question of labour exchanges. The merits of the German system of labour exchanges were fully recognised by the Conference, and the four members of the Parliamentary Committee of the Trades Union Congress who recently visited Germany testified to their success. A resolution approving the establishment of Labour Exchanges on a national basis, under the control of the Board of Trade, provided that the management Boards contain an equal proportion of employers and representatives from trades unions, was passed unanimously. Probably before long an experiment on the lines suggested will be tried. It will be noted that the Trade Unions make a point of being fully represented upon the management of the exchanges. What should be the attitude of these labour exchanges in matters where the interests of employers and employees are opposed? Should the exchange intervene in questions of wages and conditions of labour in the sense of refusing to notify situations in which wages and conditions do not conform to the "recognised," or trade union, standard? In Germany that question has been answered in the negative. No public labour exchange regards the enforcement of any particular conditions of labour as within its operations. All the exchange does is to put employer and workman into communication. They must make their own bargain. Any man willing to accept an exceptionally low wage is at liberty to do so. This principle seems to have been generally accepted in Germany by trade unionists as much as by others. Will there be equal readiness on the part of trade unionists here to accept it? Then as to the attitude of the public exchanges in times of open dispute between the two parties? Shall men be supplied through these agencies to take the places of others on strike or locked out? In Germany four principal alternatives have been adopted by different exchanges. (1) To ignore disputes altogether, *i.e.*, to send workmen to a vacancy due to a dispute in exactly the same way as to any other. (2) To register vacancies created by a dispute and to notify them to applicants for work, but in doing so to give formal notice of the dispute to the individual applicants. (3) To suspend operations within the range of the dispute during its continuance. (4) To make action in each case depend upon the meeting and decision of the Industrial Court sitting as an industrial tribunal. The second of these alterations has, it is said, most approved itself in practice.

The Shrinkage of "farmed" Land.—The agricultural statistics for 1908, just issued by the Board of Agriculture and Fisheries, show that the shrinkage of the acreage returned as under crops and grass, *i.e.*, what may properly be termed the "farmed" area, which has steadily continued year by year for the last seventeen years, was again apparent in 1908, the loss amounting to 32,000 acres in the year. Since 1891 the farmed land of Great Britain has, in round numbers, been reduced by half a million acres. Some of it consisted of land on the economic margin of cultivation which has reverted to unproductiveness, but probably the larger part has been withdrawn from farming for more profitable uses. This seems to be indicated by the fact that, generally speaking, the loss of agricultural area has in late years been greatest in those centres where urban extension is most active. The conversion of arable land into pasture proceeds with equal certainty and with much greater speed than the reduction of the agricultural area. In

1908, the plough was stopped over 170,000 acres, while on the other hand, 138,000 acres were added to grass. The total extent of arable land, which thirty-five years ago amounted to 18½ million acres, has now fallen to little more than 14,750,000 acres. The loss is almost entirely in England and Wales, the reduction in Scotland having been comparatively trifling. Taking the average of the three years, 1876-8 as the standard, since that period the loss in England and Wales has exceeded 20 per cent., while in Scotland it has been less than 4 per cent. In England the reduction has been relatively least in Norfolk, Lincoln, and the East Riding, where it has been little more than 6 per cent, and greatest in the Midland, West Midland, and South-Eastern groups, where it has amonnted to about 30 per cent.

The Woollen and Worsted Industries.—The term "woollen industry" is only technically used for that section of the wool textile trade which concerns itself with the manufacture of shoddy or heavy woollen goods. The older form of the industry, which manufactures goods from the raw wool, is now known as the worsted industry. Both the woollen and the worsted industries in respect of their organisation are in a state of semi-development. In some cases manufacturers buy the raw material, finish it, and sell the cloth themselves. Instead of specialisation in each department all the commercial and industrial processes are gathered together under one roof. For the last eighty years the wool auction sales in London have been the centre of the international wool trade, but it looks as if the metropolitan supremacy will soon be a thing of the past. Most of the wool sold at the London sales is Australian, but some comes from South Africa and South America. But most of the South American wool goes to Liverpool where there are sales as in London. Lecturing on the subject the other day Mr. Israel M. Sieff argued that London ought to give up its place as the centre of the wool sales, Bradford being the better place, for it is the centre of the wool-working industries. Probably as grading becomes more perfect Bradford will become more and more the centre of the trade. At one time the market for English-grown wool was the more important branch of the trade but it is no longer so. Not much more than one-fifth of the wool used in England is home grown, a great deal of English wool being exported to the United States.

Cheapening Insurance.—In America there has been agitation for cheaper rates of assurance under non-profit sharing policies issued for the whole term of life, and probably British offices will be found ready by-and-bye to make concessions in this direction. The tables show that there has been some increase in longevity among healthy males during the last forty years, but on the other hand the average rate of interest obtained by all British offices on investment funds has fallen considerably during the same period. Moreover, the concessions already made have been substantial. Surrender values have been granted, which has deprived the offices of a considerable source of profit; the system of applying surrender values automatically to keeping policies in form when premiums are overdue is another concession. So with the deletion of the suicide clause after the lapse of a short term of years from the date of the policy, and in the case of some companies its total abolition; whilst the more liberal conditions granted in respect of foreign travel are a boon to many. The present variations in the rates of different companies for whole life policies without profits are only slight, and without any tariff association for keeping up of rates it may safely be assumed that they will find and retain something like their true economic level.

CORRESPONDENCE.

DEW-PONDS.

Will you allow me a few lines more on the above topic? Referring to Mr. George Hubbard's letter of the 15th inst., I certainly have not the smallest desire to poach on Messrs. Hubbards' preserves. It was in 1776 that White of Selborne wrote his luminous notes on the subject of dew-ponds. I have systematically tramped the South Downs, and pondered over the problems suggested by their dew-ponds, for more years than I care to acknowledge. Messrs. Hubbards' thoughtful book helped me to shape my ideas as to the relation of these ponds to the requirements of the primitive inhabitants of Britain, a subject for many years of great interest to me.

To any of the readers of the *Journal* desirous of a water supply by means of dew-ponds, I should not commend the method detailed by Mr. Hubbard in the latter part of his letter. I can give an instance in which the expedient described has proved entirely unsuccessful, and think I can suggest a better plan.

A. E. Carey.

OBITUARY.

Earl Egerton.—The death occurred, on the 16th inst., at Bordighera, of Wilbraham Egerton, Earl Egerton, Viscount Salford, and Baron Egerton of Tatton, in the 78th year of his age. Educated at Eton and Christ Church, he sat in the House of Commons from 1858 to 1883, for the first ten years as representative in the Conservative interest for North Cheshire, and subsequently for Mid Cheshire. Lord Egerton owned some 25,000 acres in Lancashire, Cheshire and Derbyshire; he was keenly interested in agriculture, was an excellent judge of stock, especially horses, and did much to promote the

breeding of shires, and to advance scientific agriculture generally, acting as President of the Royal Agricultural Society, the Shire Horse Society, and the Hackney Horse Society. He served on several Commissions. He was a member of the Royal Commission on Noxious Vapours, chairman of the Royal Commission on the Education of the Blind, Deaf, &c., and chairman of the Royal Commission on the Port of London in 1900. He was also chairman of the Manchester Ship Canal from 1887 to 1894. In addition to his other activities, he wrote numerous articles in the leading reviews, while his "Handbook of Indian and Oriental Arms," reached a second edition in 1896. He became a member of the Society of Arts in 1869.

QUESTIONS AND ANSWERS.

NOTICES TO CORRESPONDENTS.

On all communications must be written the name and address of the sender, not necessarily for publication, but as a guarantee of good faith.

Each question or reply should be written on a separate sheet of paper, and should bear such signature of the writer and such address as he wishes to appear.

Questions which can be answered from the usual books of reference, will not be printed.

QUESTIONS.

Early use of term "Telephone."—Some years ago I came across a description in an old book (the date was certainly not later than 1850) of an apparatus to which the name "Telephone" was applied. It was, to the best of my recollection, an arrangement of concave reflectors by which sound waves were to be collected and directed, so as to enable conversations at a distance to be carried on. An account was given of some experiments in London with the apparatus, whether successful or not I do not remember. There was nothing particularly interesting about the device, except the name. But the early application of the word is certainly curious, and worth recovery for record. I cannot find that I made any note at the time, and recent search amongst likely books has been unsuccessful. Can any reader of the *Journal* help me?—R. G. T.

ANSWERS.

Ambitty.—The similarity of this word to the Swedish "ombyta," change, shifting, seems too marked to be accidental. Perhaps the early workers in glass came from the far north and brought their "terms" with them. It would be interesting to know if other technical words in glass melting bear similar resemblances.—W. Thomlinson.

Afforestation Profits.—The question asked by Mr. Aylwin was answered by Professor Somerville in a paper which he read recently before the Royal Statistical Society. "After meeting expenses," he says, "the Prussian and Bavarian State forests leave practically 10s. per acre of net revenue, the figures for Saxony and Würtemberg being 21s. and 25s. respectively. In none of these cases do the outgoings amount to 50 per cent. of the gross receipts, but in this country expenses of management are probably higher, and may not be materially, if at all, less than 50 per cent."

Fire-Walking.—I have never come across any satisfactory explanation of the secret of fire-walking. An interesting account of the ceremony may be found in the *Journal* of the Polynesian Society, for March, 1899. It is written by Colonel Gudgeon, British Resident of Rasontongo, who himself underwent the ordeal. He states that before he stepped on the fire, the priest said to one of the four Europeans present, "I hand my *mana* (power) over to you, lead your friends across," but beyond this nothing was done to prepare them for the oven. One of the four was badly burned, but the others got across unscathed. "I walked with bare feet," writes Colonel Gudgeon, "and after we had done so about two hundred Maoris followed. I did not walk quickly across the oven, but with deliberation, because I feared that I should tread on a sharp point of the stones, and fall. My feet also were very tender. I did not mention the fact, but my impression as I crossed the oven was that the skin would all peel off my feet. Yet all I really felt when the task was accomplished, was a tingling sensation, not unlike electric shocks on the soles of my feet, and this continued for seven hours or more. The really funny thing is that, though the stones were hot enough an hour afterwards to burn up green branches of the *ti* [a New Zealand tree], the very tender skin of my feet was not even hardened by the fire."

I am very glad that "Ignis" has asked this question in the *Journal*, and I hope that some member will be able to throw a light on a problem at which I, for one, have always been greatly puzzled.—Maori.

GENERAL NOTES.

Bryan Donkin Fund.—The first award under the Bryan Donkin Fund for grants in aid of original research in Mechanical Engineering will be made by the Council of the Institution of Mechanical Engineers in February, 1910. The amount available will be about £27. The applications may be sent to the Council during the current year.

PORTRAITS OF MEMBERS.—Messrs. Maull and Fox have for some years taken photographic portraits of members of the Society, and they have just presented the Society with a fresh series of cabinet-sized portraits. They have expressed their willingness to take photographs of members of the Society gratuitously and to present a copy to the sitter. Their present temporary address is 35, Sackville-street, W., but they hope to return to 187A, Piccadilly (where they have been housed for upwards of sixty years) on the completion of the re-building of the premises next Christmas.

THE SHIPBUILDING AGREEMENT.—By a decisive majority—14,514 for and 9,563 against—the new working agreement in the shipbuilding trade has been approved by the members of the twenty-six trade unions concerned. It represents a working agreement between employers and employed in shipbuilding framed on lines which promise much. Intended to avert strikes and lock-outs when disputes and differences arise in the trade, as they will from time to time. its essential feature is that the trade is made its own arbiter. After a succession of conferences between masters and men over any dispute, there is to be reference to a final court of appeal in the shape of a tribunal composed of representatives of all the trades concerned in the industry, and of the federated employers of the whole kingdom. The workers retain the right of striking, but it must be with the support and consent of the whole of their fellow workers. And so with the employers. An employer cannot lock out without the consent and support of his fellow employers.

SMALL FRUIT IN THE UNITED KINGDOM.—The agricultural returns just issued show that while practically no change occurred in the area under orchards in 1905 when compared with the previous year, 2,705 acres were added to the area under small fruit. This is the largest extension of the small fruit area recorded since 1895, and represents 3·3 per cent. increase on the area in 1907. The counties in which the most noteworthy additions were made are Kent and Cambridge. Kent has by far the largest area of any county under small fruit, 24,137 acres, of which 8,008 are in strawberries, and 7,589 in currants and gooseberries. Cambridge comes next with a total of 6,875 acres, of which 2,542 are in currants and gooseberries and 2,411 in strawberries. It is commonly supposed that a large portion of the English strawberries that come into market are from Cornwall, but only 621 acres are under strawberries in that county as compared with the 8,008 of Kent, and the total acreage under small fruit in Cornwall is only 1,657 as compared with 24,137 acres of Kent. In the acreage under orchards Devon with its 26,575 acres takes the lead as against 24,448 in Hereford, Kent coming third with 13,089 acres. Hereford has the largest acreage under pears, but it is only 1,300, Kent coming next with 889, the acreage in Devon under this fruit being only 41. It appears that 27,433 acres of small fruit was in orchards, the total extent of land under fruit cultivation in Great Britain being about 308,000 acres, of which a very large proportion is in England. Of the total acreage of orchards 63 per cent. is on grass, and it is to be observed that in the cider-growing countries practically the whole of the orchards are in this category.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

MARCH 31.—"The Island of St. Helena." By JOHN C. MELLISS, M.Inst.C.E., F.G.S. SIR WILLIAM HOOD TREACHER, K.C.M.G., Member of the Council, will preside.

MEETINGS AFTER EASTER.

APRIL 21.—"The Foundations of Stained Glass Work." By NOEL HEATON, B.Sc., F.C.S. SIR WILLIAM B. RICHMOND, K.C.B., R.A., will preside.

APRIL 28.—"The Resources of the Peruvian Andes and Amazon." By C. REGINALD ENOCK, F.R.G.S.

MAY 5.—"English Furniture Design and Construction." By PERCY A. WELLS.

MAY 12.—"The Principles of Heredity as Applied to the Artificial Production of new forms of Plants and Animals." (Aldred Lecture.) By PROFESSOR ARTHUR DENDY, D.Sc., F.R.S., F.L.S.

MAY 19.—"Railway Development in China." By ARTHUR JOHN BARRY, M.Inst.C.E.

MAY 26.—"The Manufacture of Nitrate of Lime from Atmospheric Nitrogen." By SAM EYDE.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

APRIL 29.—"The Problem of Indian Labour Supply." By SELWYN HOWE FREMANTLE, I.C.S.

MAY 13.—"Some Phases of Hinduism." By KRISHNA GOBINDA GUPTA (Member of the Council of India).

MAY 27.—"The Function of Schools of Art in India." By CECIL L. BURNS, Principal of the Bombay School of Art. PROFESSOR SIR HUBERT VON HERKOMER, C.V.O., D.C.L., R.A., will preside.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

APRIL 6.—"Ceylon: its Industries and Material Progress." By the Hon. JOHN FERGUSON, C.M.G. The RT. HON. SIR WEST RIDGEWAY, G.C.B., G.C.M.G., K.C.S.I., will preside.

APRIL 20.—"South Africa." By the HON. CHARLES GIDEON MURRAY. LORD BRASSEY, G.C.B., D.C.L., LL.D., will preside.

MAY 18.—

Cantor Lectures.

Monday evenings, at 8 o'clock:—

George Gerald Stoney, M.Inst.C.E., "Steam Turbines." Three Lectures.

Lecture II.—March 29.—Applications of steam turbines—Exhaust turbines—Mixed pressure turbines—Condensers and vacuum augmentor—Turbo-dynamos and alternators—Turbo-pumps and compressors.

Lecture III.—April 5.—The marine steam turbine—Early history—"Turbinia"—Comparative trials between reciprocating engine and turbine ships—Application to war ships—The great express Cunarders, "Mauretania" and "Lusitania"—Conclusion.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 29...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. George Gerald Stoney, "Steam Turbines." (Lecture II.)

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

British Architects, 9, Conduit-street, W., 8 p.m. Sir Aston Webb, "Buildings for Higher Technical Education."

Tuesday, March 30...Royal Institution, Albemarle-street, W., 3 p.m. Prof. F. W. Mott, "The Evolution of the Brain as an Organ of Mind." (Lecture VI.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. Arnulph Mallock's paper, "Construction and Wear of Roads."

Faraday Society, in the Library of the Institute of Electrical Engineers, 92, Victoria-street, S.W., 8 p.m. 1. Dr. F. Mollwo Perkin, "The Electro-Analysis of Mercury Compounds with a Gold Cathode." 2. Dr. E. B. R. Prideaux, "The Relation between Composition and Conductivity in Solutions of Meta- and Ortho-Phosphoric Acids." 3. Messrs. E. Sabersky and E. Adler, "A New Electrical Hardening Furnace." 4. Dr. F. G. Donnan, "Experiments on the Finlay Alkali Chlorine Cell."

Wednesday, March 31...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. John C. Melliss, "The Island of St. Helena."

United Service Institution, Whitehall, S.W., 3 p.m. Major W. H. Greenly, "The Cavalry of Frederick the Great: its Training, Leading, and Employment in War."

Naval Architects (At the House of the Royal Society of Arts, John-street, Adelphi, W.C.). Annual Conference, 11½ p.m. 1. Address by the Chairman, the Right Hon. Earl Cawdor. 2. Presentation of the Gold Medal of the Institution to Captain T. J. Tressidder, and of the Premium to Mr. W. S. Abell. 3. Lord Brassey, "Types of Warships Omitted in Recent Programmes of Naval Construction." 4. Mr. Archibald Denny, "Standardisation." A Report on the Work done by the Engineering Standards Committee on Sections and Tests for Materials used in the Construction of Ships and their Machinery. 5. Professor J. P. Henderson, "The Vibration of Ships and the Use of a Dynamical Model for Determining the Elasticity of Ships."

Thursday, April 1...Linnean, Burlington-house, W., 8 p.m. 1. Miss Stopes, "Cretaceous Petrifactions of Plants from Japan." 2. Mr. A. D. Darbishire, "Results of Breeding Experiments with Peas, Showing Mendelian Phenomena." 3. Mr. A. O. Walker, "Amphipoda Hyperiideae of the 'Sealark' Expedition." 4. Mr. J. C. Melvill, "Marine Mollusca of the 'Sealark' Expedition." 5. Mr. E. R. Sykes, "Mollusca of the Seychelles Archipelago."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. G. H. Bryan, "Aerial Flight in Theory and Practice." (Lecture II.)

Civil and Mechanical Engineers, Caxton-hall, Westminster, S.W., 8 p.m. Dr. J. S. Owens, "Storms, and their Effect upon the Sea Coast."

Dante Society, 38, Conduit-street, W., 8 p.m. The Duchess of Sutherland, "Benjamin Constant."

Paint and Varnish Society, St. Bride's Institute, Bride-lane, E.C., 8 p.m. Mr. W. G. Aston, "Lake Pigments—their Manufacture and Use."

Chemical, Burlington-house, W., 8½ p.m. 1. Mr. V. H. Veley, "The Affinity Values of Certain Alkaloids." 2. Mr. F. D. Chattaway, "The Preparation and Properties of the Nitrobrome Substituted Hydrazines usually styled the Diazoperbromides." 3. Mr. P. C. C. Isherwood, "The Coloured Salts and Derivatives of the Thio-Violuric Group." (Preliminary Note.) 4. Mr. J. C. Cain, "Nitrosoacetylamino Derivatives of the Benzene and Diaphonyl Series."

Naval Architects (at the House of the Royal Society of Arts, John-street, Adelphi, W.C.). Annual Conference, 11½ a.m. 1. Mr. H. C. Anstey, "Some Considerations on the Application of Internal Combustion Engines for Marine Propulsion." 2. Mr. F. R. S. Bircham, "Internal Combustion Engines for Submarines." 3. Lieut.-Col. G. Rota, "The Propulsion of Ships by Means of Contrary Turning Screws on a Common Axis." 4. Mr. J. H. Heck, "Note on a Mechanical Method for Determining the Thrust of Propellers." 7½ p.m. 1. Messrs. Anthony G. Lyster and W. Boyd, "Description of the Suction Dredger *Leviathan*, recently constructed for the Port of Liverpool." 2. Mr. C. J. Blackburn, "The Turbine Passenger Steamer *Ben-my-Chree*, and Practical Experience of the Parsons Marine Steam Turbine." 3. Mr. C. E. Stromeyer, "Explosions of Steam Pipes due to Water Hammer."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Friday, April 2...Naval Architects (at the House of the Royal Society of Arts, John-street, Adelphi, W.C.). Annual Conference, 11½ a.m. 1. "Report of the Experimental Tank Committee (1908)." 2. Dr. T. E. Stanton, "The Resistance of Thin Plates and Models in a Current of Water." 3. Mr. A. W. Johns, "The Accelerated Motion of Bodies in Water, with Special Application to the Rolling of Ships." 4. Mr. John Smith, "Launching Calculations, with Special Reference to the Effect of Camber." 5. Sir George Greenhill, "A Note on Ship Geometry." 7½ p.m. 1. Prof. Herbert C. Sadler, "Some Points in Connection with Shipbuilding on the Great Lakes, U.S.A." 2. Dr. J. Bruhn, ""The Influence of Form and Bulkheads on the Strength of Ships." 3. Prof. G. W. Hovgaard, "Diverging Waves."

Royal Institution, Albemarle-street, W., 9 p.m. Prof. Sir J. J. Thomson, "Electrical Striations."

Saturday, April 3...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Sir J. J. Thomson, "Properties of Matter." (Lecture VI.)

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FRIDAY, APRIL 2, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, APRIL 5th, 8 p.m. (Cantor Lecture.) GEORGE GERALD STONEY, M.Inst.C.E., "Steam Turbines." (Lecture III.)

TUESDAY, APRIL 6th, 4.30 p m. (Colonial Section.) JOHN FERGUSON, C.M.G., "Ceylon: its Industries and Material Progress."

Further particulars of the Society's meetings will be found at the end of this number.

QUESTIONS AND ANSWERS.

In view of the fact that the Royal Society of Arts includes amongst its members authorities on almost every branch of human knowledge, it has been suggested that the value and interest of the *Journal* would be greatly enhanced if some space were devoted to correspondence of the "Notes and Queries" order. Readers in search of information on particular points which cannot be obtained from the usual books of reference, are, therefore, invited to make their wants known in the *Journal*, in the hope that they may be assisted in their difficulties by their fellow members. Further particulars will be found under the heading "Questions and Answers," on p. 414.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1s. 6d. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURE.

On Monday evening, March 29th, Mr. GEORGE GERALD STONEY, M.Inst.C.E., delivered the second lecture of his course on "Steam Turbines."

The lectures will be published in the *Journal* during the summer recess.

SIXTEENTH ORDINARY MEETING.

Wednesday, March 31st, 1909, 8 p.m.; Sir WILLIAM HOOD TREACHER, K.C.M.G., Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

de Voss, Mrs. Emilia V., 5, Eichenstrasse, Gross Flottbek, Holstein, Germany.

Forsyth, John Lloyd, West Rand Consolidated Mines, Limited, P.O. Box 38, Krugersdorp, Transvaal, South Africa.

Line, George, Messrs. John Line and Sons, Limited, 213-215, Tottenham Court-road, W.

The following candidates were balloted for and duly elected members of the Society:—

Carson, James Campbell, 8, Wellington-place, Belfast.

Datta, Dina Nath Prithu, M.D., Hoshiarpur, Punjab, India.

Garrod, James Best, 96, Lavender-grove, Dalston, N.E.

Mallik, Satyendra Chandra, I.C.S., care of Messrs. Grindlay and Co., Calcutta, India.

Sim Boon Kwang, 73, Scotts-road, Singapore, Straits Settlements.

Smith, Charles Arthur, Moorhill, Totley, near Sheffield.

Yow Ngan Pan, Chop Lo Kee Seng, 28, Market-street, Singapore, Straits Settlements.

The paper read was—

THE ISLAND OF ST. HELENA.

By John C. Melliss, M.Inst.C.E., F.G.S.

The island of St. Helena has generally been thought interesting only on account of the part it played, for some 25 years, in the history of Napoleon Buonaparte who lived there in exile from October 15th, 1815, until May 5th, 1822, and whose body, after death, remained there until October 8th, 1840, when it was removed to Paris.

Many books have been written which treat of Napoleon and St. Helena, none of them perhaps of greater interest than "The Last Phase," by Lord Rosebery.

Apart, however, from its connection with Napoleon, St. Helena presents some intensely interesting problems in natural history which, even up to the present time, have completely puzzled the most able scientists.

Many scientific men of the greatest eminence have, from time to time, visited the island and written about it. These include such men as Halley, Maskelyne, and Waddington, the celebrated astronomers, who, as far back as 1676-1761, spent some time there for astronomical observations.

Also, during the last century, in 1805-13, the celebrated travellers and botanists, Dr. Roxburgh and Dr. Burchell, devoted much time to the investigation of its botanical productions. In more recent times Darwin spent some time on the island examining its natural history, and it has also occupied, to a large extent, the attention of such eminent scientists as Huxley, Hooker and Wallace, all of whom have written about the peculiar flora and fauna of the island, which appears to have no counterpart whatever in any other part of the world.

Dr. Hooker, in his address to the British Association at Nottingham in 1863,* says :—

"Neither geological considerations, nor botanical affinity, nor all these combined, have yet helped us to a complete solution of this problem which is at present the *bête-noire* of botanists. Ocean islands are, in fact, to the naturalist what comets are to the astronomer; and even that pregnant doctrine of the origin and succession of life, which we owe to Darwin, and which is to us what the spectrum analysis is to the physicist, has not proved sufficient to unravel the tangled phenomena."

The indigenous flora of St. Helena comprises seventy-seven different kinds of plants, locally known as "cabbage-trees," "gumwood," "red wood," "dog wood," "scrubwood;" and also twenty-six kinds of tree and smaller ferns.

Some fifty of these plants are absolutely peculiar to the island and cannot be regarded as specific allies of any other plants at all. A peculiar feature connected with them is that, with scarce an exception, all the flowering plants produce pure white blossoms.

There is one remarkable indigenous land bird (*Ægialitis Sanctæ-Helenæ*), a small variety of plover, locally called "the wire bird." There are some twenty varieties of marine fish which are entirely peculiar to the locality.*

There are some twenty species of land shells which are quite indigenous, and have not been met with elsewhere. Thirteen of these have already become extinct, and are now found only in a dead state on the surface of the ground, where the native vegetation has disappeared. Among these latter is the very remarkable land snail (*Bulimus auris-vulpina*) which is so highly prized by collectors, and several smaller *Bulimi* and *Succineæ*, a delicate amber-like species, a few of which may still be found living on the native "cabbage trees."

Out of a total of two hundred and three species of beetles found on the island, some one hundred and twenty-nine are true aborigines, and have been found nowhere else on the globe. One of these, a large black Carabus (*Haplothorax Burchellii*), also greatly valued by collectors, is now all but extinct.

Dr. Wallace says,† of these beetles :—

"As they mainly represent species which are specially attached to certain groups of plants, we may be sure that the plants were there long before the insects established themselves. However ancient then is the insect fauna, the flora must be more ancient still."

How did these plants and insects originate? How did they get to this remote and isolated spot, and why are they gradually becoming extinct? These are questions still waiting for an answer. The gradual dying out of the native plants has been attributed to the introduction of exotic plants and goats, which in the one case have overgrown and killed the native vegetation, and in the other have destroyed the young plants, but anyone who has studied the subject

* "Insular Floras."

* Proceedings of the Zoological Society, 20th March, 18.. and April, 1869.

† "Island Life."

on the spot cannot fail to arrive at the conclusion that these reasons are wholly insufficient to account for this fact.

Change of climate may possibly be a contributory cause of the passing away of this wonderfully interesting indigenous flora and fauna. That such a change has occurred is very probable, seeing that the island has at some remote period been much larger and more lofty than it is at present.

The extreme age of the island presents another matter of intense interest. That it is prodigiously ancient is perfectly evident, and the time since it first commenced to appear might well run into millions of years. It is wholly of volcanic origin, consisting of many layers of basalts, lavas, laterite or baked mud, scoriæ, and volcanic ashes. It is very typical of those oceanic volcanos such as "Palma" of the Canaries and "St. Paul's" island in the Indian Ocean, of which Sir Charles Lyell writes as follows*:—

> "Every crater must almost invariably have one side much lower than all the others—viz., that side towards which the prevailing winds blow, and to which therefore showers of dust and scoriæ are rarely carried during eruptions. There will always be one point on this lowest side more depressed than all the rest, by which, in the event of a partial submergence, the sea may enter as often as the tide rises, or as often as the wind blows from that quarter."

In size, St. Helena now measures about 10¾ miles long by 8¼ miles wide. The coast line is very much indented, and measures some 30 miles. The superficial area is about 30,000 acres, one-half of which, the interior, is covered to a considerable depth with a rich alluvial, productive soil, derived from decomposed lava and other volcanic products. The coast is mountainous and rugged, and picturesque in the extreme; inaccessible precipices rise from the sea as high as 500 to 2,000 feet.

The island is traversed by a high central ridge of a semi-circular form, with a maximum altitude of 2,700 feet. The portion on the south side of this ridge, known as "Sandy Bay," has the shape of a huge bowl or crater, four miles in diameter, with one of its sides broken away down to and below sea level. On the north and west of the great central ridge the ground slopes gradually away at an angle of 8 to 10 degrees, and terminates in precipitous cliffs, caused by the erosive action of the sea. From these cliffs, extending a mile out to sea, the water is shallow, only some 60 or 70 fathoms deep, but beyond that there is no sea bottom at a depth of 250 fathoms, and midway between St. Helena and Africa the depth increases to 2,860 fathoms. A corresponding depth of water exists on the other side, between the island and South America. The northern and western part of the island is built up of alternating beds of very compact blue basaltic lava, red laterite or baked mud, cinders and ashes. Some 60 to 70 of these beds can be distinctly traced, and if each of them represents a volcanic outburst, which, according to Dr. Piazzi Smith's estimate, might occur once in a century, it is easy to account for some 7,000 years at least as necessary for the building up of this portion of the island prior to the existence of any life thereon and without taking into account the long periods occupied in the disintegration and denudation of the high land and the coast, as well as the deep water-worn ravines which intersect it at all points.

The "Sandy Bay" side—the crater from which the northern and western portions of the island were ejected—shows evidence of very violent subterranean forces which have produced numerous fissures. These have been filled from below with molten lava of a more compact and harder character than the adjacent formation, and where the latter has weathered away more quickly than the former, numerous fantastically-shaped dykes now stand out; these have received the local names of "Lot," "Lot's Wife," "The Asses' Ears," and "The Chimney."

The eastern portion of the island differs somewhat, inasmuch as though it is formed of an equal number of beds of lava, &c., they are much more felspathic in character. They have evidently been thrown out from some other crater, the position of which it is not easy to locate. Both lava and mud beds in this locality are of a grey colour, and the latter contain a considerable quantity of veins of manganese (*Pyrolusite*), the only metallic ore, except a small amount of ironstone, which exists in the island. It, however, is of a very hard character, and difficult to mine.

The "Barn Rock" shows an interesting instance of upheaval—"High Knoll" is a type of several small lateral volcanic cones, and "The Waterfall" is an interesting example of a very ancient, extinct "solfatara." There is no sign of any recent volcanic action, nor of any quick cooling of the lavas. It is interesting to note that earthquakes, thunder and lightning are practically unknown.

* "Manual of Elementary Geology."

The rise and fall of tide is almost imperceptible, not exceeding about 3 feet.

That a very strong current sets round the Cape from the Indian Ocean towards St. Helena is evidenced by the fact that seeds of plants which grow in the Mauritius are often found washed ashore at "Sandy Bay." The existence of this current was remarkably demonstrated in the year 1851 when the body of the Rev. J. H. Beck, a missionary, buried at sea near the Cape, floated for 21 days over some 1,200 miles and was cast up on the shore at "Sandy Bay." This occurrence is interesting also as it was the expressed wish of Mr. Beck to be buried at St. Helena and not at sea.

An exceedingly remarkable phenomenon, not yet well accounted for, is what is known locally as "the rollers." Regularly, every year, about February and March, these rolling waves occur when the south-east trade winds give place for a short time to a dead calm. In the year 1846 they were so great that ships of 130 tons were lifted bodily from their anchorage and thrown broadside on to the shore. Fortunately they seldom exhibit this degree of violence.

The climate of St. Helena is almost without an equal, presenting no extremes of heat or cold but enjoying an abundance of bright sunshine and blue sky. It is situated but 16° south of the equator and about 6° west of Greenwich, and is singularly free from violent atmospheric disturbances and also from malarial fever and other diseases. The cool south-east trade wind is almost continuous, and this with a sea current nearly direct from the Antarctic regions gives its climate quite a temperate and equable character, the temperature ranging from 49° to 75° Fahrenheit. The annual rainfall amounts to about 8 inches in Jamestown, and 44 inches on the high land. The spring months extend from October to December, the summer months are January to March, and so on. The seasons are the reverse of those in England.

It has an abundant supply of pure, fresh spring water, and in addition to its indigenous flora and fauna there are numberless imported plants from both semi-tropical and temperate climes which grow and flourish. Oaks, bamboos, mimosas, gorse, bananas, arums, roses, geraniums, fuchsias, fields of hay and pasture, together with a thousand or more varieties of trees, fruits and vegetables, all combine to make the place with its scenery as picturesque as it is possible to imagine.

Situated almost in the middle of the South Atlantic Ocean—distant 1,100 miles from West Africa, 2,000 miles from South America, 1,700 miles from the Cape, and 4,000 miles from England, it is reached from the latter in 14 days and from South Africa in half that time—a more ideal spot could not be found for tired Britishers, either from Europe or Africa, in which to recruit their health.

The island was first discovered early in the sixteenth century, on the 21st May, 1502, by a Portuguese navigator named Juan de Nova Castella, and he called it "St. Helena," after the mother of the Emperor Constantine. It had no human inhabitants at that time, but was "densely covered with an evergreen mantle of luxuriant forest of gumwood, ebony, and other indigenous trees overhanging the seaward precipices." He also found there sea fowl, sea lions, and turtle, and he left on the island some "goats, asses, and hogs."

Eleven years later, in 1513, the Portuguese put on shore there its first human resident, one Fernandez Lopez, a military officer of high rank who had fallen into disgrace while serving in India under General Alphonso Albuquerque, and preferred exile in St. Helena to returning to his native country. A few negro slaves, some poultry, partridges, guinea fowls, pheasants, fruit trees and vegetable seeds were generously left there with him. This small community was very shortly afterwards augmented by several runaway slaves from ships, and also by a Portuguese Franciscan, who elected to take up his abode there.

The island was of great service to the Portuguese as a place of call for their ships trading to and from the East. Dutch and Spanish ships, too, used it at this period, and it became the scene of many squabbles between those different nationalities.

It was first visited by the British in 1588, eighty-six years after its discovery, when Captain Cavendish, returning from a voyage of discovery, anchored his ship off "Chapell Valley" (now called James's Valley, after King James II.). He records that at that time he found there "a small settlement, a Roman Catholic church, some handsome buildings, many fruits and vegetables, and a great store of partridges, which were very tame, not making any great haste to fly away, also plenty of pheasants, which were very big and fat, and many swine, which were very wild and of great bigness, and seldom would abide any man to come near them."

The British took a fancy to this promising

place, as they usually do, and soon realised its great value as a place of call for outward and homeward bound ships trading with the East; and it was shortly after visited by Captain Kendall, with his ship the *Royal Merchant*, and Captain Lancaster with the *Bonaventure*, who were the pioneers of British trade with India.

The Dutch also, about this time, became keenly alive to the great value of the island, and in 1651 they took formal possession of it, but not for long, as the British East India Company wrested it from them, and were secured in their occupation by a charter from King Charles II. The company fortified the place, and set to work to develop it. This so excited the envy of the Dutch that in 1665 they attacked the British, drove them out, and again obtained possession.

Many fierce and bitter struggles now ensued between the British and the Dutch for the island, the accounts of which are extremely interesting. Scarcely a year had elapsed before the British fought the Dutch, and were successful in dispossessing them, but in 1673 the Dutch returned to the struggle, and again successfully expelled the British. Finally, Captain (afterwards Sir Richard) Munden, R.N., succeeded in overpowering the Dutch, and again recovered possession. The island since then has remained as a part of the British Empire.

For some 182 years, until 1838 when its government reverted to the Crown, the East India Company owned and managed the island, and during the whole of that time they lavished large sums of money upon its upkeep.

The Records during the whole of this period are still preserved, and are extremely interesting, being in many respects both quaint and even amusing. They tell of the slavery which at that time existed; of the sale by public auction of human beings for £40 to £150 per head; and of the severe punishments meted out to these slaves for almost trivial offences. They received capital punishment for merely striking a white person. Hanging alive in chains, pouring hot sealing wax on the naked skin, and such like punishments continued until the year 1832, when the Company freed all the slaves at a cost of £28,000. These Records tell, too, of the peculiarities of some of the officials from time to time, *e.g.*, how Governor Bouchier wasted the Company's money by turning the Government Gardens into pasture for his asses, and building a shed 400 feet long in order that he might indulge in donkey riding in all weathers.

The serious mutinies which in those times occurred in the garrison, in one of which, in 1692, the mutineers barbarously murdered Governor Johnson, are all most interestingly described. It was during these early days that no lawyer was permitted to reside on the island lest he should encourage litigation. Quakers were also, for some reason or other, expelled, and parsons, engineers, and doctors were treated with a high hand. The parson who persisted in omitting the prayer in church for the Governor and Council on the ground that, in his opinion, they were not worth praying for, was only brought to a better state of mind by having his pay stopped. Engineer Christian Frederic Vogell, who showed himself "to be more of a pyoneer than engineer, and no gentleman, was accordingly dismissed the Hon. Company's service." Dr. Hicks, however, seemed worse than any of them, and of him it is recorded that, "for being drunk and breaking the peace in the street with his sword drawn, he be fined and his sword sold to the soldiers of the guard." It must, however, not be overlooked that, as a rule, the Governors and leading officials were men of the highest character, ability, and integrity.

During Napoleon's residence—1815-26—the whole community enjoyed a most prosperous time, the maintenance of several British regiments and ships of war, which patrolled the coast, involving a large circulation of money. Entirely apart from the use made of it in connection with Napoleon, St. Helena has served the British Empire in many ways, first of all in the building up of her great commercial intercourse with India and the East, which, without it, as a place of call for ships, would have been impossible.

Again, during the years 1840-65, it was used as a depôt in the great cause of humanity during the suppression of the slave trade on the West coast of Africa. More recently it has been used as a place of custody for "Dinizulu" and other Zulu chiefs; and again, at a later date, it was used for the safe keeping of General Cronje, with some 6,000 prisoners of war, who surrendered to General Roberts during the recent South African war. It now forms one of the most important stations for the "all British" telegraph cable between Great Britain, South Africa, and Australasia.

For some 250 years the island has been regarded as one of Great Britain's most valuable naval stations, and there are many

naval and military experts who still hold that opinion. It has during the past been carefully fortified and garrisoned until recently, October 29th, 1906, when the whole of the garrison was removed, and for the first time in its history the place was left defenceless and practically abandoned, so that any foreign power may step in and take it. Much valuable property is consequently going to ruin, and the British residents, some 3,500 English-speaking persons, owing to this, as well as to the diversion of trade by the Suez Canal, have consequently fallen on very evil times. There is now no longer any market for their cattle, poultry, and other produce, and some of them, especially wives and children of soldiers married without leave and left to their fate, are reduced to the verge of starvation. It is said, indeed, that several children have already died through want. The Colonial Surgeon is left single-handed to look after this community, and owing to the long distances at which many of them live from Jamestown there is more work than one medical man can attend to.

The St. Helena Committee in London are doing good work in pressing the claims of the inhabitants, and the Colonial Office has made a small grant for the establishment of a flax mill to encourage the cultivation of New Zealand flax (*Phormium tenax*), also for teaching and encouraging lace making, but these industries are insufficient to restore anything like even partial prosperity to the island.

It would be but a small expense to retain the place for Imperial purposes, as a very small garrison, naval or military, would suffice to keep up the barracks, fortifications, guns, roads, waterworks, &c., and prevent them from going to ruin.

The importance of the island to the Empire cannot be overrated, seeing that in time of war it would be an easy matter to cut off Great Britain from her eastern and southern possessions by blocking the Suez Canal, and by cutting the telegraph wires which pass through foreign countries.

NOTE.—There is a model of St. Helena in the Rotunda, at the Royal Academy, Woolwich; also a collection of its rocks, minerals, and soils in the Sedgwick Museum, Cambridge. A collection of dried indigenous plants exists in The Herbarium, Royal Botanic Gardens, Kew. A collection of marine fishes, birds, and insects is at The Natural History Museum, South Kensington, W.; and much valuable literature, relating to the island, is to be found in the Library of the Royal Colonial Institute, Northumberland-avenue, W.C.

DISCUSSION.

The CHAIRMAN (Sir William Hood Treacher), in opening the discussion, said that the little island of St. Helena was of peculiar interest so far as its fauna and flora were concerned, because it produced 50 different kinds of plants, 20 varieties of marine fish, 20 species of land shells, and 120 sorts of beetles which were found nowhere else on the globe. The problems there presented to naturalists, zoologists, and geologists had not yet been solved, but a not altogether improbable hypothesis which might solve the conundrum was, he believed, that the island was a relic of a vast submerged continent. The author had stated that nearly all the flowering shrubs produced pure white flowers; that the island was free from earthquakes and other atmospheric disturbances, and also from malarial fever and lawyers, so that it would seem to be a little earthly paradise; a statement tempered somewhat by the fact that occasionally, even in dead calms, rollers lifted big vessels out of their anchorage and laid them broadside on the shore. It had been described by a Russian traveller as an emerald set in granite. The island was called after St. Helĕna, and, that being so, he wished to ask the author why it was always called St. Helēna? St. Helena was the mother of Constantine the Great, one of the first of the noble Roman ladies baptised into Christianity, and it was stated in one account of her life she was a native of Britain. It, therefore, seemed fitting that the little emerald set in granite should be one of the natural jewels of the British Crown, and it seemed a pity that this great nation could not afford a little financial assistance to the island, which had fallen on bad times, not through its own fault in any way, but simply because a Frenchman cut the Suez Canal, and because the British nation had no more prisoners of war who required board and lodging. The author had stated that the island was still of great imperial importance, and he was sure all present would wish good luck to the efforts of the St. Helena Committee, which was trying to soften the hard hearts of the Colonial Office, although he believed no Government office had any hearts to soften. At any rate the real invincible person whom they could not get over was the Chancellor of the Exchequer. Having regard to the present state of public opinion he was afraid there was very little chance of St. Helena being re-garrisoned, so that the fortifications which were re-constructed not many years ago would moulder into decay. He had read that whale fishing used to be a great industry with the islanders, from £13,000 to £30,000 a year being obtained from it. The author had not referred to that subject, and it would be interesting to know whether the whale fishing still existed, or whether the statement was a myth.

MR. A. G. WISE (Secretary of the St. Helena Committee) desired to remove a misconception that

had arisen with regard to the purpose of the St. Helena Committee. It had aimed at relieving the distress on the island, and it had endeavoured, not altogether without success, to soften the hearts of the Colonial Office and the Chancellor of the Exchequer; but it had not appealed to the public, nor was it the intention to do so, for funds to distribute as charity among the islanders. Lord Elgin, when he was Secretary of State for the Colonies, thought that would be a proper course for the Committee to pursue, but after carefully considering the matter, the Committee decided that it was not their place to be a kind of Charity Organisation Society, but that it was an Imperial duty to get the island out of the mess into which the Government had put it. Mr. Haldane pointed out with triumph that by withdrawing the troops from St. Helena a saving of £35,000 per annum had been effected, but it it did not seem a large order to suggest that some of that money should be spent in starting reproductive industries for the benefit of the island. That view had been adopted to a certain extent, £5,000 being voted for starting of a flax industry and £500 for the commencement of a lace industry for the women and children. While the flax industry had been fairly successful, he had just heard from the island that in all probability it would be necesssary to close down the factory for three months, because there was not a sufficiency of the flax to enable it to go on working. That was due to the fact that there were 2,000 head of cattle on the island, which, so long as they were allowed to remain, made it impossible for the flax industry to be a success. The Admiralty had made an offer to purchase 200 head of cattle, but the amount offered was not such as the farmers could accept, and the committee were now urging upon the Colonial Office to make a grant of about £1,000 to supplement the offer made. The Admiralty pointed out that they were not a philanthropic body, and could not offer more than the definite market value of the cattle, which were wanted for naval requirements on the Cape station. He maintained there was some kind of Imperial obligation in regard to the question of cattle, because, at the request of former Governors, and for the benefit of the military, the farmers were continually asked to improve the breed of their live stock, being assured that they would always be taken for military purposes. Those promises had not been fulfilled, with the result that the farmers had been left with 2,000 cattle on their hands which were practically useless, as the people on the island were unable, owing to their poverty, to purchase meat. The cattle were a great impediment to the growing of the flax because if they were not there the pasture lands they now occupied would be used for the cultivation of that plant. The Committee had learned with great interest that the Salvation Army had formulated a scheme in connection with the island. It was necessary to avoid any tendency to exaggerate the state of affairs in the island. The latest official report which was, unfortunately, two years old, stated that two children had died of starvation, the Governor reporting that it was due to the apathy of the parents. Personally he could not conceive any parent being so inhuman, and although the Governor of St. Helena had done his work admirably, he thought there must be some kind of official negligence if such a condition of affairs existed. His latest information was to the effect that there was a very slight tendency towards improvement, but the present state of things could not go on for long. The labouring classes could only get occasional employment at very low wages; this re-acted on the merchants and farmers, and consequently things were at a very low ebb all round. He, therefore, contended it was the bounden duty of the Government to come to the rescue of the island.

Mr. B. R. BALFOUR stated that some years ago he spent a few months on the island in the capacity of a lay reader, the clergy being very short of help. Between 4,000 and 5,000 Boer prisoners of war were then resident there. He noticed that the roads on the island were in a very bad state, and thought it was a pity some attempt was not made to utilise the services of the prisoners in repairing them, as they were very glad to do any kind of work, particularly gardening. While there were some depressing items in the Governor's Report, there were also some encouraging features, among them being the statements that the jail was empty for 116 days of the year, and that on some occasions, when acting as Judge, he had been presented with a pair of white gloves on account of the absence of crime. The Governor further stated that he believed the new industry of flax growing was likely to be prosperous; and that if the owners of property would all pull together and work for the benefit of the island progress would be made. The climate in the higher part of the island was exceedingly good, but he would not recommend anyone to settle in Jamestown, the town being hemmed in between huge masses of rock which had the effect of making the place very hot. The St. Helena Committee had suggested that the island might be made a tourist resort, and he thought it would be an exceedingly good thing for the island if somebody with capital converted one of the many available houses into a first-rate hotel, which would induce people to go there. There was only one doctor on the island, who received a very small salary, and he suggested the Government should make a larger grant in this direction. Much benefit to St. Helena might also result if trees were planted there. He hoped the paper would have the result of interesting the people of this country in an out-of-the-way island which was in need of help.

On the motion of the CHAIRMAN, a hearty vote of

thanks was accorded to Mr. Melliss for his interesting paper.

Mr. MELLISS, in reply, said a good deal of difference of opinion existed with regard to the question of the pronunciation of the name of the island, but it had never been satisfactorily proved why it should be called St. Helēna. He believed the whale fishing was still carried on, but entirely by a large American fleet, so that it was not of much benefit to the island, the ships only obtaining a certain amount of fresh water and provisions from it.

JAPANESE EXHIBITION IN LONDON.

The Times announces that it is officially informed that an exhibition of the arts, sciences, manufactures, industries, and products of Great Britain and Japan, on an extensive scale, will be held at Shepherd's-bush next year.

The Imperial Japanese Government are supporting the scheme with keen interest, and financial aid will also be forthcoming. A Bill relating to the exhibition has just received the approbation of the Imperial Diet, and in the case of the House of Representatives the sanction was given unanimously.

There is reason to believe that the British Government are also in sympathy with the project.

Some officials of the Japanese Department of Agriculture and Commerce sent by the Government have lately been in London, and they have returned to Japan, after having concluded satisfactory arrangements with the British organisers.

Distinguished personages in this country have already identified themselves with the proposed exhibition, and signs are not lacking that it will prove to be a very important and successful event in the coming year.

DRYING PLANT FOR INDIA.

The Director-General for Commercial Intelligence, India (Mr. F. Noel-Paton), draws attention to the need in India for special drying plants capable of dealing with the conditions as regards atmospheric humidity existent in that country. In the rainy season certain industries in India suffer from the difficulty of drying their products or materials.

An example of this is furnished by the flour-milling industry in India. The ordinary wheat of Indian commerce contains a relatively large percentage of dirt, although the penalties imposed under the export contract now in force has tended to abate this defect so far as grain for shipment is concerned. Before wheat in a dirty state can be milled, it must be not only screened and scrubbed but washed, and the process of subsequent drying is troublesome, costly, and at times injurious. The usual method is that the wet wheat after passing through a centrifuge is discharged into the head of a vertical shaft containing baffles, and as it descends it meets an ascending current of increasingly hot air from gills that are heated by steam. This method is successful except in the rains; but during the rains the miller must let his wheat go to the silo and ultimately to the rolls with an excessive percentage of moisture, seeing that an indefinite intensification of the heat results in destruction of the starch globules, and consequent injury to the flour. The excessive moisture is apt to entail inefficient milling and a decline in the percentage of fine flour in relation to offals. This is to some extent made good by the larger percentage of water sold as flour, but to an equal extent the flour loses value in the eyes of the baker. The baker founds his estimation of a flour largely on the weight of bread he can produce from a given measure of it, and this depends mainly on the quantity of water that may safely be added to it; and, in fact, the effort to reduce moisture in flour during the rains to such proportions as will insure the keeping qualities of the product is often attended by injury resulting from the employment of an injuriously high temperature. Indian bakers know that the processes of their calling are fraught with peculiar difficulties in the rains, not only because of accidents to the yeast, but because of the comparative weakness of the flour and its liability to decomposition of various kinds.

The tanning industry would also gain greatly by an appliance that would dry the air in the monsoon without reliance on condensation processes. In one large tannery in India no attempt to dry hides is made during two months of the year. This, of course, involves serious interference with the ordinary course of manufacture and an incomplete employment of capital. In some parts of the country the most serious difficulty is that of retarding the drying of the hides during the hot weather. At other seasons drying is artificially and very slowly effected by the use of steam pipes. The hides are suspended over and above these pipes; but the saturation of the atmosphere is such that the drying process occupies a number of days. During that time the hides have to be frequently wiped to free them from the moulds that grow profusely under such conditions; but it need scarcely be said that those moulds work considerable mischief in the course of a week or so, and even if they are superficially removed they may leave their spores in the leather to germinate so soon as favourable conditions recur, as they frequently do in India.

In the manufacture of sugar, deterioration in colour results from the creation of invert sugar during drying. At present a relatively low colour as distinguishing the indigenous article is considered a recommendation in some Indian markets, but in India as a whole the consumption of true refined sugar is increasing steadily and the prejudice referred to cannot be expected to persist. The drying of sugar after it leaves

the centrifuge is commonly effected by means of a cylinder that is heated by steam and rotates upon an inclined axis. But when the air is virtually saturated, a disproportionate expenditure of heat is necessary to impart to it any drying power.

So also in the drying of copra and in the desiccation of plantains for plantain meal and of various substances for the production of starch, it is the custom in other countries to rely upon a simple heating of the atmospheric air with such measure of humidity as may be present. But several of these substances are not only peculiarly liable to decomposition and discolouration through prolongation of the process of drying, but are also sensitive as regards excessive heat. There is reason to believe that if a suitable drying plant were devised a very great stimulus might be given to these industries, which are already attracting considerable interest.

In all these cases the drying is conducted or attempted by raising the temperature of a damp air to such a point that it may be enabled to assimilate more moisture. But in proportion as the humidity of the air increases any increment in temperature becomes more injurious. It would, therefore, be preferable to desiccate the air and pass it over the goods to be dried.

There are also other processes, such as wool-washing and the scrubbing of seed lac, to which an apparatus of the kind in question might not improbably be applied with advantage.

COMMERCIAL USES OF THE DOGFISH.

Fishermen on the Nova Scotia coast have been complaining for some time past about the prevalence of the dogfish, which is proving very destructive, as the pests not only take the bait, but often destroy the trawls and scare the fish from the fishing grounds, besides destroying large quantities of them. Very recently the dogfish has been on the increase, and, naturally, more hurtful to the fishing industry; but action has now been taken to make the pest financially valuable. According to the American Consul at Yarmouth, Nova Scotia, a dogfish reduction factory was established, about a year ago, at Canso, on the north-eastern coast of Nova Scotia, and large quantities of these fish have been treated there. In fact the works became so beneficial that the plant has been largely increased, and has become very remunerative to the proprietors as well as to the fishermen. Another plant has recently been established at Clark's Harbour, about thirty-five miles from Yarmouth. There is also a third at Shipegan, in New Brunswick. The Clark's Harbour plant is larger, and is said to be better and more modern than either of the others. The building is 138 by 40 feet. and has a very perfect machinery equipment. A splendid wharf has been built, leading out to the deep water, to facilitate loading. The fish are taken from the vessels and piled into wagons and carried to the "cooker," which is a long iron cylinder boiler-like affair. Steam is forced into this cylinder from both ends, and the fish thoroughly cooked, when they are transported to the press, where the oil is extracted. From the press the oil flows into tanks arranged with steam-pipes at the bottom, and supplied with water. The oil floating in the first tank is drained off through a conduit to the next tank, and so on to the fifth and last, when it is perfectly clear, drawn off into casks, and is ready for the market. Up to the present time New York has taken all the output of the factory, and also all that from the Canso works, the average price being 1s. 4d. per gallon. After the oil is drained off, the remains of the fish fall into a screw conveyer and are taken to the dryer, to which dry heat is supplied from a large brick furnace, a steam driver forcing the air into the dryer, after which the fertiliser is conveyed by a screw conveyer to the packing-room, where it is put into bags, for sale to the farmers of the country. With the exception of the 40 horse-power engine, which was built in Nova Scotia, all the machinery comes from New York. The Canso works are planned for day and night work, and reduce about twenty-five tons of fish in twenty-four hours. The Clark's Harbour plant will, it is said, reduce thirty tons of fish in ten hours, employing from ten to twelve men. These are Dominion Government plants. Not only will dogfish be utilised and reduced to useful fish oil and fertiliser, but all kinds of fish offal will be made use of and reduced to a commercial value. Much that is now useless to the fishermen and thrown away, will find a ready sale, and will add very considerably to the fishermen's profits. It is not expected that the local fishermen can supply material enough to keep the factories fully working, but small vessels will be employed, and collecting stations established along the coast, for the purpose of obtaining the dogfish and other non-eatable fish, and fish remains. Fishermen are greatly pleased with this new industry, as it will make a market for thousands of pounds of fish otherwise useless. These dogfish have been caught in the past in large quantities, and, after being killed, thrown overboard, but now they may become valuable, and, in a way, will prove of commercial importance.

TURKISH MEERSCHAUM DEPOSITS.

Meerschaum is mined at Kahe, in the vilayet of Angora, but principally in the Eski-Shehr. It is found in nodular form. At one time the fuller's earth, found about three feet thick overlying the meerschaum deposits, was collected and shipped to the coast, but this industry has died out, and the mining of the meerschaum alone is of commercial interest. Any person wishing to mine this substance can obtain a permit to do so from the Turkish Administration of Mines. It is said that the pits at Nemlau have been worked for two thousand years.

The meerschaum mined here is, according to the American Consul-General at Constantinople, in small yellowish nuggets, very resistant and compact. The meerschaum mines, which at one time reached from Kahe to Mihalitch, on the Sea of Marmora, are to-day reduced to some twelve hundred and seventy pits, concentrated round the city of Eski-Shehr, and giving employment to some five thousand miners. These mines are worked in the most primitive manner by a foreman and two to five workmen, with picks. The depths of the pits vary greatly, and depend upon the depth at which a reddish-brown earth is met, which is the first indication of the existence of magnesite. Sometimes this red earth is found only a few yards beneath the surface, but ordinarily at a depth of twenty yards, often forty, and even sixty. In this layer of red earth meerschaum is fonnd, disseminated in nuggets of irregular shape. The size of these rarely exceeds twelve to sixteen cubic inches; the greater part are of the size of a walnut. When the diggers reach this stratum they continue their working in one or two horizontal galleries, leaving natural columns. No explosives are necessary as there are no rocks. Some of these galleries have a length of over four hundred yards, and, as they are dug without any plan, it is not uncommon for two properties to meet. The first treatment received by the meerschaum after being brought to the surface is to clear it from the adhering earthy matter by scraping with a special knife. In this state it is sold to the local merchants, who dry and clean it, polish it with wax, and then sort it into qualities and sizes. There are thirteen recognised qualities, and these are again assorted into four principal sizes, the names of which and the number of pieces to the case are as follows:—Lager (*sira-mali*), 30 to 40; gross baumvolle (*biri-binlik*), 70 to 90; klein baumvolle (*pamoukli*), 140 to 170; soliste kaeten (*taneli*), 300 to 350. These are the principal sizes, but there are four smaller sizes, of which each case contains the following number of pieces: 500, 800, 1,200, and 1,500. These smaller cases are classed in only two qualities. There are two standard sizes of cases. For the first three sizes of nuggets, the case is 6¾ by 13½ by 28 inches, and for the five other sizes, 7½ by 14¾ by 32 inches. These are the sizes recognised by the Government, no other sizes being permitted. The prices of these cases are as follows, according to the size and quality of the nodules:—Sira-mali, from £18 10s. to £45 17s.; biri-binlik, from £11 to £18 19s.; pamoulki, from £4 12s. to £9 4s.; taneli, from £1 17s. to £3 14s. There is much waste in preparing the product for the market, the adherence of earthy matter thereto rendering it useless. Almost the entire output of the article is sent to Vienna, and thence distributed to the various European countries and to the United States, the latter country taking only the first four sizes, and that only in the first seven qualities. The United States is considered to be the best customer, and it therefore seems surprising that American purchases should not be made on the spot, or through Constantinople instead of through Vienna. If the Turkish meerschaum mines were developed they would be an important source of income to the Empire. Derindge, in the Gulf of Ismidt, which is connected by the Anatolian railway with Eski-Shehr, is the port of shipment for meerschaum. Shipments for Austria are sent *viâ* Trieste, and those for France *viâ* Marseilles.

HOME INDUSTRIES.

The Port of London.—Yesterday, the Port of London Act came into operation, and brings with it the new Port Authority, whose duty it will be to deal with the whole business of the Thames, from its mouth to Teddington. The Port of London Authority will be responsible for the administration of what has long been, and under sagacious control may long continue to be, the greatest port in the world. Into it pass every year some 5,000 vessels, of a total tonnage of, in round figures, 34,000,000, the value of their cargoes, outward and inward, being estimated at not less than £400,000,000. The docks cover a superficies of 640 acres of water and 1,800 acres of land, and have a capital value of £25,000,000. As Sir Hudson Kearley pointed out at the first meeting of the Port of London Authority, held a few days ago, rival ports, not only on the Continent, but in this country also, by the wise expenditure of capital have been enabled to keep abreast of the requirements of the day. Circumstances, unfortunately, have prevented London from doing all that is necessary in this respect, and the reason is not far to seek. There has been paralysing division of authority. Interests have worked in different ways, and without larger authority and revenue powers than Parliament has been willing to entrust to them, those responsible for making provision for the trade of the Port have done much less than was necessary. The new Authority comes into existence with adequate administrative and financial powers, it is admirably constituted, and there is confident expectation that it will be equal to its opportunities. German and Belgian ports are serious competitors now-a-days, but the splendid natural advantages of the Port of London; its geographical position; the magnitude, wealth, and energy of the population behind it; the fine approach from the sea; the river tides, strong enough to transport traffic easily to all parts yet not so violent as to make navigation difficult; these and other advantages insure the continued pre-eminence of the Port of London if only there is systematic execution of adequate improvements.

The Trade Boards' Bill.—The President of the Board of Trade has introduced his Bill to abolish sweating and establish a minimum wage. It is proposed to schedule certain trades in which "by

reason of the prevalence of evil conditions no organisation has yet taken root, and, in consequence, no parity of bargaining power can be said to exist." Certain trades are scheduled; others may be added by and bye. The scheduled trades are four—ready-made and wholesale bespoke tailoring; card-board box making; machine-made lace and net finishing; and ready-made blouse making. The want of natural organisation is to be met by setting up an artificial organisation for these sweated industries. The Trade Boards are to consist of representatives of masters and workpeople in equal numbers, together with official members nominated by the Board of Trade. One of them is always to be chairman, while there can be no quorum unless one of them is present. The primary duty of these Trade Boards is to regulate the rates of wages by establishing a *minimum* wage for the trade or branch of a trade with which they are concerned. When their decisions have been confirmed by the Board of Trade they are to be binding upon all employers, who may not pay anything less than the *minimum* under penalties enforceable in any court of summary jurisdiction. Officers appointed by the Trade Boards or the Board of Trade will have full power to inspect books, documents, or premises, and to prosecute in person without recourse to a lawyer. Everyone will sympathise with the object of the Bill. It remains to be seen whether, assuming it becomes law, it will effect the object aimed at, or materially improve the condition of the class it is intended to assist. It has to be remembered that these sweated trades are poor trades from every point of view, and there are those who think that if the Act succeeds in killing the sweating it will kill the trade altogether.

The Victoria Experiment.—The Bill is frankly experimental, and the proposed limitation of its operations, to begin with, seems wise. Of course, the principle of the *minimum* rate is no new principle in this country. In all Government works fixed minimum rates exist for the different classes of labour employed. Collective bargaining has given the great organised trades such rates for themselves. The mining, the engineering, and the cotton industries have them. Others have succeeded in setting up similar standards by means ot arbitration under the Board of Trade, when the arbitrator, sitting as chairman of a joint committee of employers and employed, has fixed piece-work rates for industries like the boot and shoe trade, and even for so complicated an industry as the Nottingham lace trade with success. In Australia the Special Boards Legislation of Victoria furnishes something more than a working model of Wages Boards. Victoria started her system of Wages Boards in 1896 with five special Boards, which in 1907 had multiplied to forty-nine. The trades chosen for the first experiments were the most heavily sweated in Melbourne—clothing, boot and shoe making, shirt making, furniture, and bread making. The first Wages Boards Act was passed for four years only, in the teeth of considerable opposition from the representatives of employers in the Legislature. But when the time came for renewing the Act some of its leading opponents supported its re-enactment, not only as an engine for putting down sweating, but as a useful instrument for the suppression of the dishonest employer, and the Act has now been made permanent. In his report on "the Wages Boards and Industrial Conciliation and Arbitration Acts of Australia and New Zealand," Mr. Aves says that as regards sweating "there is abundant testimony to the fact of improvement, under Wages Boards." He states that in the matter of "levelling up," the Boards "may almost be regarded as having won general approval," and he alludes to the "widely-spread belief that the Boards have been instrumental in diminishing, some say in abolishing, sweating." The Bill now before Parliament is not identical with the Victorian Act, but it proceeds on the same lines, and its operation will be watched with keen interest and even anxiety.

Short Time in the Spinning Industry. — The replies to the circular sent out by the Federation to spinners of American cotton does not justify any recommendation to a general decrease in production. As anticipated in these Notes, the necessary four-fifths majority was not obtained. It is the new mills that have been the determining factor in the rejection of the short time policy, and individual spinners must now consider what is best in the individual case. Many spinners are already running short time. The cotton trade could hardly be worse than it is just now. Short time would seem to be particularly suited to those definite and general contractions in the demand for labour due to what may be called cyclical fluctuations. The method was applied with great success in the severe depression of 1903-4. In the previous year the Federation of Master Cotton Spinners passed a resolution to close their mills during the whole of Whit week, and on every Saturday and Monday, from the 27th June onward. The effect was to reduce the normal week from 55 to 40 hours. This first period of short time ended in the autumn of 1903, but after a short interval of slightly improved activity short time was reimposed in the spring of 1904, and lasted till September or October, when the depression gave way to extreme prosperity.

Traders and the Railway Amalgamation.—There has been considerable anxiety among traders and others using the lines affected at the possible results of the working union proposed by the Great Northern, Great Central, and Great Eastern Railway Companies, but the new clauses which these companies have agreed with the Board of Trade to insert into their Bill for amalgamation should go far to allay this anxiety. As is generally known, the conveyance rate per mile for merchandise falls as the distance increases, the highest scale of charges operating for

the first twenty miles, or any part of such distance. The charges are lower for the next thirty miles, lower again for the next fifty miles, and still lower for the remainder of the distance. It was reasonable to stipulate that in the calculation of minimum rates for merchandise conveyed over the railways of the three companies, or any two of them, the distance should be reckoned continuously as one railway, and thus avoid more than one application of the higher rates. This has been secured by the first of the clauses referred to above. The second provides that the ordinary passenger fares in force on the railways of the three companies on the date of the passing of the Act (including the charges for season tickets, market tickets, and week-end tickets), shall not be increased by reason of the passing of the Act, or at all unless the Joint Committee can prove on complaint that such increase is not due directly or indirectly to the passing of the Act. And much the same stipulation is to be enforced in respect of the rates and charges of merchandise and minerals, whilst Clause IV. provides that the facilities as a whole afforded by the Joint Committee for either passengers, goods, or mineral traffic shall not be unreasonably diminished as compared with the facilities afforded by the companies during the year 1908. And compensation is to be provided for servants of the companies in their permanent employment prior to the 1st of January, 1908, who shall be discharged by reason of the passing of the Act.

CORRESPONDENCE.

THE WOOLLEN AND WORSTED INDUSTRIES.

Your paragraph on this subject in last week's *Journal* is certainly misleading not to say inaccurate. The term "woollen industry" is by no means confined to the shoddy manufacturers in the heavy woollen district, nor is the term "worsted industry" confined to those who use raw wools. Dewsbury, Batley and the Calder Valley are known as the "heavy woollen district." but outside those districts there are large centres manufacturing woollen goods and using large quantities of raw wool, such as Huddersfield, the Spen Valley, Leeds, Hawick, &c. With regard to raw wools the long wools are combed for the "worsted" industry, whilst short wools are carded and used for the "woollen" trade. Now with regard to London giving up its place to Bradford for the sale of Colonial wools at auction, there is another side of the question which has to be carefully considered, viz., the effect it would have on the foreign trade for colonial wools.

London is a port and all the wools are stored and inspected by buyers at the docks or in the neighbourhood, and consequently can be re-exported at a minimum of expense.

Bradford, on the other hand, is far inland and if the auctions were held there a large expense would be entailed on wools for re-export viz., carriage by rail from the port to Bradford and back again to the port.

At the sales just closed in London 187,252 bales were catalogued and 182,000 sold as follows:—To the home trade, 95,000 bales; to the Continent, 69,000 bales: to America, 18,000 bales. It will thus be seen that nearly half went abroad and if these had been sold in Bradford an additional expense of about 3-16ths per lb. for inland carriage would have been entailed to foreign buyers, or a total sum of nearly £20,000.

The question is, would this not have the effect of driving these foreign buyers away, direct to the sources of supply, and thus losing a large commission to those engaged in the trade in this country. Bradford is undoubtedly a very large user of Colonial wools and is entitled to every consideration, but before making such a stupendous change the question would require careful consideration from every standpoint.

GEO. HY. TATTERSFIELD.

76, Wool Exchange, Coleman-street,
London, E.C.,

QUESTIONS AND ANSWERS.

ANSWERS TO CORRESPONDENTS.

On all communications must be written the name and address of the sender, not necessarily for publication, but as a guarantee of good faith.

Each question or reply should be written on a separate sheet of paper, and should bear such signature of the writer, and such address as he wishes to appear.

Questions which can be answered from the usual books of reference, will not be printed.

QUESTIONS.

What is the relation of the two practices (at least as old as Roman times) of decorating pottery with "slip" and glass with "prunts"? Is it merely that, working in whichever material, it was equally natural to do what amounts to the same thing? Or is there anything to show that either potter or glass-worker was indebted to the other? I have seen it stated that the potter borrowed the idea from the glass-worker. Yet pottery is the more ancient art. Is there any evidence that one or other of them was first in the field?—GLASS-BLOWER.

Can anyone give me in short the genealogy of the Fleur-de-lis? If it begins as the Assyrian date-palm, by what stages does it become an iris, and when precisely does that turn into the lily of France?—ENTENTE CORDIALE.

I am interested to see that the subject of "Fire-walking" is receiving attention in the *Journal*. Like your correspondent "Maori," I have always been puzzled by this problem. I do not suppose anyone now doubts that in India as well as in Polynesia persons often walk harmlessly over yards of red-hot ashes. I can supply abundant testimony to the fact, apparently quite trustworthy, if desired. Could any of the learned members of this Society tell us how it is done? Has the problem been scientifically investigated?—W. Coldstream.

I have an ivory miniature, about 4¾" by 3¾", subject "The Music Lesson," with a cupid holding the music. The initials and date on it are E. E. 1700. Can anyone inform me who E. E. was? I have been quite unable to discover.—Torquay.

I have reeently purchased a large mill here which has some 300 horse-power of water-power from the River Derwent. It also has a very fine chimney about 160 feet high. Having regard to the large amount of water-power at my disposal, it is very unlikely that I shall make any use of the chimney for steam-raising purposes.

It has occurred to me to utilise this chimney as a shot tower for the manufacture of lead shot.

I have ascertained from the makers of shot-making plant that the chimney is very suitable, and the point I now wish to clear up is: What profit may one reasonably look forward to from the carrying on of the industry.

If you could furnish me with any reliable information on this point, I should feel extremely obliged.—Alf. R. Sennett.

ANSWER.

In reference to the note in the *Journal* of the 19th inst. about the ridding of grain from weevil, we desire to call your attention to the obvious disadvantage of bi-sulphide of carbon, *i.e.*, its great inflammability—this most dangerous property renders it practically prohibitive in the case of ships, whilst it is also extremely poisonous. On the other hand, sulphur dioxide, which is largely and regularly employed for this purpose, is compressed into a liquid, in which form it is supplied in various receptacles, from tins holding 12 oz. up to copper cylinders holding 2 cwt., and has been for a long time used for killing weevil in grain. None of the objections applying to bi-sulphide of carbon can be urged against pure sulphur dioxide gas, whilst the latter has the additional advantage of improving the colour of the grain.—A. Boake, Roberts, and Co., Ltd.

GENERAL NOTES.

Vienna International Shooting and Field-Sports Exhibition, 1910.—An International Shooting and Field-Sports Exhibition will be held in Vienna in 1910, which will include exhibits of all agricultural and trade products having any sort of connection with these matters. The object of the Exhibition is to show the amouut of economic profit to countries where hunting and shooting are encouraged, and the extent to which art, traffic, commerce, industry and trade are interested in the maintenance of those branches of sport, and the remarkably large profit which is derived from them, not only by the parties immediately interested, but also by the whole population. The Exhibition (which has the fullest support and co-operation of the Imperial and Royal Government and the Municipality of Vienna) will last about five months, from May till October, 1910. The general plan is that every State—including Austria—should have a separate space allotted to it, that the exhibits of each country should be displayed in a building or pavilion erected at that country's expense and representing either some famous historical shooting box or country seat typical of that country. The Exhibition will also afford an opportunity for holding International Hunting and Shooting Congresses, at which all the questions relating to these sports will be discussed.

The Feeble Minded and the Unemployed.—In considering the various causes of unemployment one not unimportant factor has received less attention than it deserves. Some ten years ago Parliament made it possible for education authorities to make day school and other provisions for mentally defective children. Since then special schools have been provided in which these children are taught, and to some extent, trained. London leads the way and many of the provincial towns have since followed its example. The number of defective children in the country is not as yet known with certainty, but Mrs. Mary Dendy, who has given much attention to the subject, considers the proportion to be not less than 1 per cent. of the school-going population. Heredity, drink, lack of nourishment, consumption, are among the reasons of their existence. What becomes of these weak-minded children after they leave the schools? When they leave school they are still mentally defective, but after they leave it, that is after sixteen, the law takes no further notice of them until they bring themselves again within its grasp as criminals, unemployed, or paupers. Mrs. Dendy says that two years ago they were leaving the London special schools at the rate of 800 a year. Many of them are only suitable for an asylum, but they are allowed to be at large and to become parents. They often get situations but they cannot keep them, for they are unstable and weak of will. Plainly the casual work of the mentally defective affects the work of all unskilled labourers. They take up odd jobs, and when working in gangs may do fairly well when pinched by necessity, but they cannot save against a rainy day, and seldom earn any wage that would enable them to save. Mrs. Dendy suggests that if there were special day schools for all the weak-

minded, and a colony to which to pass them on when they leave the day schools, the unemployable in the towns would soon be greatly lessened, and one of the greatest sources of physical deterioration would be removed.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock :—

APRIL 21.—"The Foundations of Stained Glass Work." By NOEL HEATON, B.Sc., F.C.S. SIR WILLIAM B. RICHMOND, K.C.B., R.A., will preside.

APRIL 28.—"The Resources of the Peruvian Andes and Amazon." By C. REGINALD ENOCK, F.R.G.S.

MAY 5.—"English Furniture Design and Construction." By PERCY A. WELLS.

MAY 12.—"The Principles of Heredity as Applied to the Artificial Production of new forms of Plants and Animals." (Aldred Lecture.) By PROFESSOR ARTHUR DENDY, D.Sc., F.R.S., F.L.S.

MAY 19.—"Railway Development in China." By ARTHUR JOHN BARRY, M.Inst.C.E.

MAY 26.—"The Manufacture of Nitrate of Lime from Atmospheric Nitrogen." By SAM EYDE.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

APRIL 29.—"The Problem of Indian Labour Supply." By SELWYN HOWE FREMANTLE, I.C.S. The RIGHT HON. VISCOUNT MIDLETON, late Secretary of State for India, will preside.

MAY 13.—"Some Phases of Hinduism." By KRISHNA GOBINDA GUPTA (Member of the Council of India).

MAY 27.—"The Function of Schools of Art in India." By CECIL L. BURNS, Principal of the Bombay School of Art. PROFESSOR SIR HUBERT VON HERKOMER, C.V.O., D.C.L., R.A., will preside.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock :—

APRIL 6.—"Ceylon: its Industries and Material Progress." By JOHN FERGUSON, C.M.G. The RT. HON. SIR WEST RIDGEWAY, G.C.B., G.C.M.G., K.C.S.I., will preside.

APRIL 20.—"South Africa." By the HON. CHARLES GIDEON MURRAY. LORD BRASSEY, G.C.B., D.C.L., LL.D., will preside.

MAY 18.—"Canada as a Field for British Investment." By J. OBED SMITH, Assistant Superintendent of Emigration, Department of the Interior, Canada.

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

GEORGE GERALD STONEY, M.Inst.C.E., "Steam Turbines." Three Lectures.

LECTURE III.—APRIL 5.—The marine steam turbine—Early history—"Turbinia"—Comparative trials between reciprocating engine and turbine ships—Application to war ships—The great express Cunarders, "Mauretania" and "Lusitania"—Conclusion.

F. W. LANCHESTER, "Aerial Flight." Three Lectures.

April 26, May 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 5 ... ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. George Gerald Stoney, "Steam Turbines." (Lecture III.)

Farmers' Club, Whitehall-rooms, Whitehall-place, S.W., 4 p.m. Mr. J. H. Diggle, "The Equipment and Cultivation of Small Holdings."

Engineers (in the Theatre of the United Service Institution, Whitehall, S.W.), 7½ p.m. Mr. Ernest R. Matthews, "The Corrosion of Steel-Reinforcement in Concrete."

Chemical Industry (London Section), Burlington-house, W., 8½ p.m. 1. Mr. Watson-Smith will Exhibit a Specimen of the now extinct Boghead Cannel Coal, or "Torbane Hill Mineral," and give a brief Historical and Chemical description of it. 2. Mr. S. Cowper Coles, "Vapour Galvanising." 3. Messrs. C. N. Hake and M. Bell, "The Action of Sulphuric and Nitric Acids in the Nitration of Cellulose."

Cold Storage and Ice Association, at the London Chamber of Commerce, Oxford-court, Cannon-street, E.C., 7½ p.m. Mr. W. D. A. Bost, "Apparatus for Determining the Conductivities of Insulating Materials."

Victoria Institute, 1, Adelphi-terrace, W.C., 4½ p.m. Mr. C. A. Carus-Wilson, "Ezekiel's Vision of the Divine Glory."

TUESDAY, APRIL 6...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Colonial Section.) Mr. John Ferguson, "Ceylon: its Industries and Material Progress."

Asiatic, 22, Albemarle-street, W., 4 p.m. Dr. M. Moszkowski, "The Pagan Races of East Sumatra."

Alpine Club, 23, Savile-row, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Discussion on Mr. Arnulph Mallock's paper, "Construction and Wear of Roads." 2. Mr. C. T. Purdy, "The 'New York Times' Building."

Photographic, 66, Russell-square, W.C., 8 p.m. Messrs. C. E. Kennett Mees and S. H. Wainwright "Some Interesting Absorption Spectra."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8 p.m. Sir Lewis Michell, "Greater South Africa."

WEDNESDAY, APRIL 7...Royal Archæological Institution, 20, Hanover-square, W., 4½ p.m. Messrs. W. H. St. John Hope and Harold Brakspear, "Excavations at Haughmond Abbey in 1906."

Astronomical, Burlington-house, W., 5 p.m.

ERRATUM.—Dr. Nisbet asks that the following correction may be made in the text of his paper read last week, on page 390 of *Journal* for March 26th. 1909, column 2, lines three and four from top, *for* "£313,000 and £843,000, or £1,156,000 in all," *read* "£530,000 and £313,000, or £843,000 in all."

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FRIDAY, APRIL 9, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURE.

On Monday evening, April 5th, Mr. GEORGE GERALD STONEY, M.Inst.C.E., delivered the third and last lecture of his course on "Steam Turbines."

On the motion of the CHAIRMAN (Sir William H. White, K.C.B., F.R.S.) a vote of thanks to the lecturer was unanimously passed.

The lectures will be published in the *Journal* during the summer recess.

COLONIAL SECTION.

On Tuesday afternoon, April 6th, Mr. JOHN FERGUSON, C.M.G., read a paper on "Ceylon: its Industries and Material Progress." The Right Hon. SIR WEST RIDGEWAY, G.C.B., G.C.M.G., K.C.S.I., presided.

The paper and discussion will be published in the *Journal* on the 23rd inst.

INDIAN SECTION.

Thursday afternoon, March 25th; the Right Hon. LORD AMPTHILL, G.C.S.I., G.C.I.E., in the chair.

The CHAIRMAN, in introducing the reader of the paper, said that Mr. Thurston had been for many years the Curator of the Government Museum at Madras. In that, as well as in his personal and private capacity, he was held in the highest esteem, in fact he was known and respected throughout the whole of the scientific world. There was a story of him which illustrated better than anything else what manner of man he was. Mr. Thurston had the misfortune to lose most of his private means through a great bank smash, a calamity which he bore with a philosophic calmness which almost amounted to indifference; but when a little later a few ancient coins which were under his charge in the museum were stolen by one of the students or assistants, he was absolutely inconsolable, that apparently trifling loss affecting him infinitely more than the loss of his private fortune. The author was one of those men on whom the progress of science very much depended, and he was also one of the public servants who maintained the honour and power of the country in the distant parts of the Empire. It was well known that many of the great discoveries and triumphs of science had been due to men who disregarded every personal consideration — their health, safety, welfare, and comfort in the pursuit of science; and Mr. Thurston was such a man, because he put everything behind his duty as the curator of the museum and as a scientist engaged in research. A visit to the Government Museum at Madras was always a very pleasant experience, although at first alarming. Such was the author's zeal for anthropometry, that he seized every man, woman, or child in order to measure them. At first this scared people who did not know his ways, but they generally went away converted and flattered by some complimentary assurance that either the size of some part of their cranium, or the particular shape of their brain, or some other physical attribute was exceptional and admirable.

The paper read was—

NATIVE MAN IN SOUTHERN INDIA.

By EDGAR THURSTON,
Superintendent, Ethnographic Survey, Madras.

The vast tract of country over which my investigations in connection with the ethnographic survey of Southern India during the last eight years have extended is commonly known as the Madras Presidency, and officially as the Presidency of Fort St. George and its dependencies. Included therein are the Native States of Travancore and Cochin, and the smaller Feudatory States of Pudukōttai, Banganapalle, and Sandūr. Briefly, the task which was set before me in 1901 as Superintendent of the Survey was to record the manners and customs and physical characteristics

of more than 300 castes and tribes, representing more than 40,000,000 individuals, spread over an area exceeding 150,000 square miles, which is 30,000 square miles in excess of that of Great Britain and Ireland.

The five principal languages spoken in Southern India are Tamil, Telugu, Malayālam, Canarese, and Oriya. Of these, the first four belong to the Dravidian family, while Oriya, which is spoken in Ganjam and a portion of the Vizagapatam district, belongs to the eastern group of the Indo-Aryan family. In the preparation of the following brief summary of the other languages and dialects, I have drawn mainly on "The Linguistic Survey of India," and "The Madras Census Report, 1901."

Savara.—The language of the Savaras of Ganjam and Vizagapatam. One of the Mundā languages.

Gadaba.—Spoken by the Gadabas of Vizagapatam and Ganjam. One of the Mundā languages.

Kond, Kandhi, or Kui.—The language of the Kondhs of Ganjam and Vizagapatam.

Gōndi.—The language of the Gōnds, a tribe which belongs to the Central Provinces, but has overflowed into Ganjam and Vizagapatam.

Gattu.—A dialect of Gōndi, spoken by some of the Gōnds in Vizagapatam.

Kōya or Kōi.—A dialect of Gōndi, spoken by the Kōyis in the Vizagapatam and Godāvari districts.

Poroja, Parjā, or Parji.—A dialect of Gōndi.

Tulu.—The language largely spoken in South Canara (the ancient Tuluva). It is described by Bishop Caldwell as one of the most highly developed languages of the Dravidian family.

Koraga.—Spoken by the Koragas of South Canara. It is said to be a dialect of Tulu.

Bellera.—Spoken by the Belleras of South Canara, and regarded as a dialect of Canarese or Tulu.

Toda.—The language of the Todas of the Nīlgiri Hills, concerning which Dr. W. H. R. Rivers writes as follows*: — "Bernhard Schmid,† who wrote in 1837, appears to have known more of the true Toda language than any one who has written since, and he ascribes two-thirds of the Toda vocabulary to Tamil, and was unable to trace the remaining third to any other language. Caldwell‡ believed the language of the Todas to be most closely allied to Tamil. According to Pope,* the language was originally old Canarese, with the addition of a few Tamil words, but he has included in his vocabulary words which have probably been borrowed from the Badagas."

Kota.—A mixture of Canarese and Tamil, spoken by the Kotas of the Nīlgiri Hills.

Badaga.—The language of the Badagas of the Nīlgiri Hills. Said to be an ancient form of Canarese.

Irula.—Spoken by the Irulas of the Nīlgiris, and said to be a dialect of Tamil. Kasuba or Kasuva is recorded as a dialect of Tamil spoken by the sub-division of the Irulas which bears the same name.

Kurumba.—Spoken by the Kurumbas of the Nīlgiri Hills, Malabar and Mysore, and regarded as a dialect of Canarese.

Konkani.—A dialect of Marāthi, spoken almost entirely in the South Canara district by Sārasvat and Konkani Brahmans and Roman Catholics.

Marāthi.—In the Tanjore district, the descendants of the former Marātha Rājas of Tanjore speak this language. It is also spoken in the Bellary district, which was formerly under Marātha dominion, by various Marātha castes, and in the State of Sandūr.

Patnūli or Khatri.—A dialect of Gujarāti, spoken by the Patnūlkārans, who have settled for the most part in the town of Madura. They are immigrants from Saurāshtra in Gujarāt, who are said to have come south at the invitation of the Nayāk kings of Madura.

Lambādi.—The language of the nomad Lambādis, Brinjāris, or Sugālis. It is described in the Census Report, 1901, as a patois "usually based on one of the vernaculars, and embroidered and diversified with thieves' slang and expressions borrowed from the various localities in which the tribe has sojourned."

Korava or Yerukala.—A dialect of Tamil spoken by the nomad caste bearing these names. Like the Lambādis, they have a thieves' slang.

Vadāri.—Recorded as a vulgar Telugu dialect, spoken by a wandering tribe of quarrymen in the Bombay Presidency, the Behars, and elsewhere. They are doubtless Oddēs or Wudder navvies, who have migrated from their home in the Telugu country.

The population of Southern India may be roughly divided into long-heads and round-heads, of whom the former prevail in the Tamil

* The Todas, 1906.
† "Madras Journ. Lit. and Sci." v. 1837.
‡ "Comparative Grammar of the Dravidian Languages."

* Outlines of the Toda grammar appended to Marshall's "Phrenologist Among the Todas."

country and Malabar. I cannot here enter into a discussion of the influences which have brought about the marked difference, shown in the following Table, in the type of cranium in the northern and southern portions of the area under consideration; and must content myself with the bald observation that, whatever may have been the influence which has brought about the existing mesaticephalic or sub-brachycephalic type, with high cephalic index, in the north, this influence has not extended southward into the Tamil and Malayālam countries, where Dravidian man remains dolicho- or sub-dolichocephalic.

Class.	Language.	Cephalic Index.
Sukun Sāte	Marathi	82·2
Vakkaliga	Canarese	81·7
Billava	Tulu	80·1
Rangāri	Marathi	79·8
Agasa	Canarese	78·5
Bant	Tulu	78·
Kāpu	Telugu	78·
Golla	Telugu	77·5
Pallan	Tamil	75·9
Mukkuvan	Malayālam	75·1
Nāyar	Malayālam	74·4
Vellāla	Tamil	74·1

A character, with which I am very familiar, when measuring all sorts and conditions of Natives in Southern India, is the absence of convexity of the segment formed by the posterior portion of the united parietal bones. The result is that the back of the head, instead of forming a curve gradually increasing from the top of the head towards the occipital region, forms a flattened area of considerable length almost at right angles to the base of the skull. This character is shown in a marked degree in the photograph exhibited, which represents a prosperous Linga Banajiga in the Canarese country.

The Linga Banajigas are a trading section of Lingayats, who are a religious sect, abounding in the Canarese country, whose distinctive characteristic is the wearing of a linga—the symbol of the god Siva—made of steatite, or soapstone, and enclosed in a metal casket, often of silver, and sometimes encrusted with precious stones, or, among the poorer classes, enclosed in a cloth of a particular colour. The linga should always be worn, both by males and females, and is buried with the corpse. A Lingayat shopkeeper, who was not wearing it, explained that he removed it during working hours, as it was necessary to tell a little lie when doing business. The linga is worn on various parts of the body—the head, arm, chest, and waist. Sometimes, in addition to the linga, a rosary of rudrāksha beads is worn as a necklace. In connection with the rudrāksha, the legend runs that Siva or Kālāgni Rudra, while engaged in Tripura Samhāra, opened his third eye, which led to the destruction of the three cities, of which Rākshasas or Asuras had taken the form. From this eye liquid is said to have trickled on the ground, and from this arose the rudrāksha tree (*Elæocarpus Ganitrus*). The mere mention of the word rudrāksha is believed to secure religious merit. Rudrāksha beads are valued according to the number of their lobes (or faces, as they are called), which are usually five in number. A bead with six lobes is believed to be specially good, and one with two lobes, called Gauri sankara rudrāksha, is very highly valued. Dikshitar Brāhmans wear a two-lobed bead mounted in gold.

Among the Arādhya Brāhmans, who wear both the sacred thread and the linga, the popular belief is that if, by some accident, the linga is lost, an individual must either fast until it is recovered, or not survive so dire a calamity. The linga is the life of him who wears it, and, when he loses it beyond recovery, he loses his own life. Incredible stories are told of miraculous recoveries of the linga. In one case, it is said to have returned to its owner, making a loud noise in water; and in another it was found in a box under lock and key. In this connection, the following story is narrated by Colonel Wilks:—* "Poornia, the present Minister of Mysore, relates an incident of a Lingayat friend of his, who had unhappily lost his portable God, and came to take a last farewell. The Indians, like more enlightened nations, readily laugh at the absurdities of every sect but their own, and Poornia gave him better counsel. It is a part of the ceremonial preceding the sacrifice of the individual that the principal persons of the sect should assemble on the bank of some holy stream, and, placing in a basket the lingam images of the whole assembly, purify them in the sacred waters. The destined victim, in conformity to the advice of his friend, suddenly seized the basket, and overturned its contents into the rapid Caveri. 'Now, my friends,' said he, 'we are on equal terms; let us prepare to die together.' The discussion terminated according to expectation. The whole party took an oath of inviolable secrecy, and each privately

* "Historical Sketches of the South of India."

provided himself with a new image of the lingam."

The Lingayat priests are called Jangams, some of whom are religious mendicants. One of the latter, whom I saw at Sandūr, was clad in very elaborate begging attire, which included sandals studded with blunt nails. On one occasion a friend came across a man sitting in the verandah of his house, from within which groans proceeded. It was explained that his wife was swinging on a swing studded with sharp nails, to cure him—by sympathetic magic—of some trifling ailment.

Some Pandāram mendicants wear the linga in a casket, and have an apparatus consisting of iron triangles round the neck in performance of a vow. When proceeding on a pilgrimage to the Temple of Subramaniya Swāmi at Palni, some devotees pierce their cheeks with a long silver needle, which traverses the mouth cavity; pierce the tongue with a silver arrow, which is passed vertically through the protruded organ; and place a silver shield (mouth-lock) in front of the mouth. Some Dāsaris (Vaishnavite mendicants) have permanent holes in their cheeks, into which they insert the needle when they go about the country in pursuit of their profession.

I turn for a few moments to a consideration of the various peoples, past and present, in Southern India. The pre-historic inhabitants are abundantly represented by tumuli, cairns, cromlechs, palæolithic, and neolithic implements, pottery, &c. Pre-historic stone celts are believed by the Malaiālis of the Shevaroy Hills to be the thunderbolts of Vishnu, and are stacked as votive offerings in their shrines dedicated to Vignēswara, the elephant god who averts evil. The Burmese believe that, when the powers above quarrel, they throw celts at one another, and that, when one misses, it falls to the earth. They attach considerable importance to them for medicinal purposes, and powdered celt is said to be equally good for a pain in the stomach or an inflamed eye. The cromlechs on the Nīlgiri Hills are believed to have been built by a race of pygmies, assisted by hares and porcupines. In like manner, the big earthen burial urns, which are found in many parts of the country, are believed to have been made for a race of pygmies, or for the disposal of old women who would not die. Some Khōnds in Ganjam wear blue beads and cut agates, which are said to be dug out of ancient burial places in Central India.

The most archaic type of existing man is represented by the jungle or forest tribes, the microscopic remnant of an ancient race, living in the seclusion of the jungle, where they have more or less retained their racial purity, which is disappearing as the result of contact metamorphosis from communication with the outside world. They are short of stature, dark-skinned, and broad-nosed (platyrhine), and have nothing in common with the tall, hairy, and narrow-nosed (leptorhine) Todas, who inhabit the Nīlgiri plateau. The Todas live in picturesquely situated settlements, called mads or mands, breed a large-horned race of buffaloes, and practice the form of polyandry, in which the husbands of a woman are own brothers. "There is," Dr. Rivers writes,* "no doubt that, in former times, the polyandry of the Todas was associated with female infanticide, and it is probable that the latter custom still exists to some extent."

In former days, the Kondhs of Ganjam practised female infanticide, in the belief that the sun god, in contemplating the deplorable effects produced by the creation of feminine nature, charged men to bring up only as many females as they could restrain from producing evil to society. It was possible to come across villages, in which there was not a single female child.

The main bulk of the population is represented by the Dravidians of the plains, and, in addition, there are the Brāhmans. It is, I believe, a common idea among Anglo-Indians, that the Brāhmans alone wear the sacred thread, with which they are invested at the upanayana ceremony. This is, however, by no means the case. For example, the thread is worn by the Patnūlkārans, an extensive and go-ahead colony of weavers at Madura, who claim to be the descendants of Saurashtra Brāhmans, who migrated southward from the Saurashtra country in Gujarat. The thread is also worn by the Kōmatis, a clan of Telugu traders, who claim to be Vaisyas—the third caste of Manu. The Kōmatis have a quaint marriage custom, and one from which their families derive their distinguishing names. The figure of a cow is made of flour, and into the stomach is put a mixture of turmeric, lime, and water. After the cow has been worshipped in due form, it is cut up, and to the different families is sent that portion which they are entitled to receive, one getting the horns, another the neck or

* "The Todas," 1900.

hump, and so on. The sacred thread is also worn by the Kammālans or artisan class, who claim to be descended from Visva Karma, the architect of the gods, and to be Visva Brāhmāns, calling the true Brāhmans Gō or Cow Brāhmans. By some Kammālans of Malabar the adelphic form of polyandry is practised. It is said that a girl may have a series of brothers, ranging in age from five to twenty-five, whom she has to regard as her husbands. The Malabar Kammālans boast that their system of polyandry is the result of the sojourn of the exiled Pāndavas, with their common wife Panchali, and their mother Kunthi, in the forests of the Valluvanād division of Malabar.

Civilisation is fast bringing about changes in manners and customs, which are sad from the ethnographist's point of view. The Shānan females, like those of some other castes in the Madura and Tinnevelly districts, have the lobes of their ears dilated by a process of gradual dilatation from infancy. A Tinnevelly missionary was an expert at removing the deformity among his converts to Christianity by operative surgery. The converts at first objected to the operation, as the shortened lobes made them look like Dēvadāsis or dancing girls, whose morality is notoriously frail. Altercations between Kallan women constantly lead to one or both parties having the dilated ear-lobes, which reach down to the shoulders, violently torn asunder. It is stated, in the Gazetteer of the Madura district, that "even at the present day, in quarrels between women of the lower castes, long ears form a favourite object of attack, and lobe-tearing cases figure frequently in police records."

Females of many castes on the west coast go about nude down to the waist. But the custom of covering the upper part of the body with a kind of towel, as a more elaborate garment, is fast gaining ground. When I was inspecting a jungle tribe in South Canara, females, young and old, removed the cotton wrapper from their chests as I passed down the line. Here the upper garment, by a reversal of Western ideas, indicated immodesty. And it is not the feeling of shame that has given rise to the covering of the body, but the covering that has provoked the feeling of shame.

Leafy garments, representing the fig leaf stage of society, are fast disappearing. Such garments, or aprons, are still worn by the Thanda Pulayans of the Cochin State. They are made from the thanda sedge, and put on, when a girl reaches maturity, with a formal ceremony called thanda kalyānam (marriage). The wearing of this garment is accounted for by a tradition that "a certain high caste man had been sowing grain and planting vegetables in his fields, but found that his daily work was in some unknown way frustrated. For whatever he planted or sowed in the day was carefully picked up and taken when men slept. So he set a watch, and one night he saw coming out of a hole hitherto unknown to him certain beings like men, but quite naked, who set to work destroying his hopes of a crop. Pursuing them, he succeeded in catching a man and a woman, and he was so ashamed of their condition that he gave the man his own upper cloth; but, not having one to spare for the woman, she (following mother Eve's example) made herself an apron of grass*." The jungle Vettuvans, of Malabar, wear aprons of leaves stitched together. The origin of this gear is said to be that, when the god Paramēswara was distributing gifts of clothing to the various peoples of the earth, he asked the Vettuvans whether they would prefer a daily or yearly change of apparel. They decided in favour of the former, and the god, to punish them for their ambition, decreed that their daily dress should consist of leaves. They change, or should change, their foliage every day at noon. A festival, which is attended by huge crowds, takes place annually at the village of Periyapalayam, near Madras, where the goddess Mariamma is worshipped under the name of Periyalayathamman. Those who attend are under a vow to wear a garment made of leafy twigs of the nīm or margosa tree (*Melia Azadirachta*), which is purchased from hawkers, who do a brisk trade. Those who belong to the more respectable classes go through the ceremony in the early morning, before the crowd has collected in its tens of thousands.

The primitive jungle man is now attempting to raise himself in the social scale, adorns his forehead with a quasi sect mark, made with ashes or tinned aniline dye, shaves his head in imitation of the Hindus, and smears his body with sandal paste in mimicry of his superiors.

Lucifer matches are now replacing the making of fire by friction, or flint and steel. The Todas of the Nīlgiris did not object to lighting the cheroots, which I gave them, with matches. But they must light the fire by

* Rev. W. J. Richards, Ind. Ant. ix., 1880.

friction at some of their daily ceremonies, and at the funerals of males. At the funeral of a Toda female, I myself supplied the matches for lighting the pyre. A fire stick, which was in current use in a Toda dairy, was polluted, and rendered useless by the touch of my Brāhman assistant! Among the Nambūdiri Brāhmans of the West Coast, the sacred fire for sacrifices should be produced by the friction of two pieces of wood. And, during their marriage rites, fire is made with pieces of wood of the jak tree (*Artocarpus integrifolia*) and pipal (*Ficus religiosa*).

A ceremony, called hook-swinging, is now viewed with disfavour by Government. Some years ago a man in a village north of the Godavari river, who had four holes in his loins from previous swingings, complained to the Deputy Commissioner that his occupation was gone, as he was no longer allowed to be swung. During one of the tours of a recent Governor of Madras, the villagers complained that, since the practical abolition of hook-swinging, the rainfall had been deficient, and the crops scanty, cholera had been prevalent, and the child-bearing capacity of the females had diminished. There is a legend that in a fight between the goddess Kāli and the demon Darika, the latter was completely defeated, and the former, biting him on the back, drank his blood to gratify her feelings of animosity. Hook-swinging symbolises this incident, and the blood shed by the insertion of the hooks through the flesh of the back is intended as an offering to the goddess. In cases of famine, cholera, or other calamity, a swinging festival used to be held, for the purpose of propitiating the deity, and, at the same time, a sacrifice of goats, sheep, pigs, fowls, and even male buffaloes, took place. As human hook-swinging is forbidden, a substituted ceremony is sometimes performed. Such a ceremony was gone through for my edification at the shrine of Mariamma at Chennapatna, in the Mysore Province. The goddess borne by a priest, and a little wooden figure of Sidi Vīranna carried by a boy, were worshipped at a tank (pond), and brought in procession to the scene of the swinging ceremony. To a long beam, Sidi Vīranna, dressed up in a gaudy turban and silk-bordered cloth, and carrying in his hands a sword and shield, was secured by means of a rope of human hair, which was tied to a hook in the middle of his back. The beam was then hoisted on high, and Sidi Vīranna was rotated round and round. Sometimes a cradle is tied to the beam, and children are swung in performance of a vow. And occasionally men, tied to the beam by ropes round the waist, are hoisted.

Turning now to the jungle tribes, let me correct a statement which is sometimes made that they are woolly-haired. Curly hair abounds, but woolly hair is never found. As a typical example of the physical characteristics of these tribes, who are represented by Paniyans, Kurumbas, Shōlagas, Irulas, and others, I may cite the Kādirs of the Anaimalais (Elephant Mountains) in the Coimbatore district. These Kādirs are excellent hands at climbing trees by means of pegs driven in with a bill-hook. The method of climbing is exactly the same as that in vogue among the Dyaks of Borneo, as described by Wallace in his "Malay Archipelago." And, like some Malay tribes, *e.g.*, the Semangs, the Kādir females wear a bamboo comb in the hair, ornamented with a design which corresponds very closely with the design on the combs worn in the Malay Peninsula. It is noted by Skeat and Blagden* that the Semang women wore in their hair a remarkable kind of comb, which appears to be worn entirely as a charm against diseases. I am informed that the Kādir combs are not looked on as charms, and the markings thereon have no mystic significance. A Kādir man should always make a comb and present it to his wife just before marriage, or at the conclusion of the marriage ceremony, and the young men vie with each other as to who can make the nicest comb. The Kādirs, like some tribes in the Malay Peninsula, have some of their teeth chipped. In the Malay Peninsula, the common way of expressing the fact that a girl has reached marriageable age is that she has had her teeth filed. The operation of chipping the teeth is performed by the Kādirs with a chisel or bill-hook and file, and carried out on both males and females at about the age of puberty. In their search for honey, the Kādirs will only remove the hives during dark nights, as the darkness gives them a feeling of security in descending a precipice by means of a fragile rope ladder. As a guarantee of their safety, they take care that their wife or son watches above, to prevent a possible enemy from letting the ladder go. And sometimes they take with them the wife of the man who is in charge of the ladder above.

The Pulayans, who inhabit the jungles at

* "Pagan Races of the Malay Peninsula. 1900."

the base of the Tinnevelly Hills, are the most unpromising specimens of dejected humanity whom I have come across. Some missionaries once attempted to conciliate them by means of a feast. When summoned to the banquet which had been prepared for them, they retired much offended, as with the food were put betel leaves and tobacco, which were of evil omen, as these articles are offered at the grave on the occasion of a funeral. I cite this incident as an example of the ignorance of the habits and superstitions of the Natives, which sometimes leads to unfortunate mistakes by those responsible for Indian administration. And I am in entire sympathy with the recent memorial, urging, *inter alia*, that selected candidates for the Indian Service should be required to take a course of study in the ethnology, sociology, and religion of the races among whom their life-work will lie.

The Ulladans of Travancore are, so far as I am aware, the only tribe who use a cross-bow. The existence of this weapon puzzled me until the word Feringhi, meaning Frank or European, was used in connection with it, and it is doubtless of Portuguese origin. Many Portuguese names still survive among Eurasians and Native Christians on the west coast, and a recent telegram, "Da Gama taking leave. Proposed that Albuquerque officiate for him," has an old time ring about it.

The jungle tribesmen depend, for shooting animals and birds for food, on bows and arrows, with barbed or blunt heads. At a long distance shooting match among the Chenchus of the Nallamalai Hills, the prize was won with a carry of only 144 yards. We have it, on the authority of a celebrated archer of Charles I., that the ordinary range of the bow was from sixteen to twenty score yards. A Chenchu, who gained the prize in a shooting match, with the face of a straw scarecrow as bull's-eye, was in an advanced state of intoxication, and naively used his success as an argument in favour of drink. It was noted by Captain Newbold that the Chenchus are not remarkably expert as archers, to judge from the awkwardness they exhibited in dispatching an unfortunate sheep picketed for them at forty yards, which was held out to them as the prize for the best marksman. Some time ago a Chenchu, who was the bully of his settlement, beat another Chenchu and his wife. The injured man appealed to the District Forest Officer, and, explaining that he knew the law did not allow him to kill his enemy, applied for a written permit to go after him with a bow and arrow.

The visual acuity of the Chenchus was tested with Cohn's letter E, No. 6. The visual acuity is represented by a fraction, of which 6 is the denominator, and the number of metres at which the letter was recognised by the individual tested is the numerator, *e.g.*,

$$V.A = \frac{13\,m}{6} = 2{\cdot}16.$$

The average distances in metres at which the letter was recognised by the various castes and tribes examined by myself and Dr. Rivers were as follows :—

16 Shōlagas (Rivers)	12·9
94 Kotas	12·8
180 Badagas	12·6
50 Paraiyans	12·5
58 Telugu ryats	12·4
28 Chenchus	12·3
55 Urālis (Rivers)	12·2
30 Brāhmans, Mysore	12·2
30 Non-Brāhmans, Mysore	12·2

In all classes, it may be noted, the average acuity was between 12 and 13 metres (13 to 14 yards), and ranged between V.A = 2·15 and V.A = 2·03. The maximum distances at which the position of the letter was recognised were : —Shōlaga, 18m.; Paraiyan, 19m.; Badaga and Dikshitar Brāhman, 20m. The nine classes, or groups of classes examined, cover a wide range of degrees of civilisation, from the wild jungle Chenchus, Shōlagas, and Urālis to the cultured Brāhman. And, though the jungle man, who has to search for his food and mark the tracks and traces of wild beasts, undoubtedly possesses a specially trained keenness of vision for the exigencies of his primitive life, the figures show that, as regards ordinary visual acuity, he has no advantage over the more highly civilised classes.

On the occasion of a Viceregal visit to Travancore, the Kānikars constructed an elaborate "tree house." They are very expert at building huts in trees, called ānamadam (elephant huts), for watching the crops, and driving away marauding wild beasts, such as pigs and elephants. The huts are made of bamboo thatched with jungle leaves, and a crude bamboo ladder connects them with the ground. When all the inmates are safely housed for the night, the ladder is removed aloft out of the reach of elephants, who, mischievously inclined, might remove the obstruction, and leave the Kānikars to regain *terra firma* the best way they can.

The Gadaba women of Vizagapatam wear a bustle or dress-improver made of fibre. This article of attire is accounted for by a tradition that a goddess visited a Gadaba village *incognita*, and asked leave of one of the women to rest on a cot. She was brusquely told that she must sit on the ground. It was ordained that thenceforth all Gadaba women should wear a bustle to remind them that they should avoid churlishness. The Gadaba females also wear cloths manufactured from cotton thread and fibre. According to a legend, when Rāma, during his banishment, was wandering in the forests of Dandaka, his wife Sīta accompanied him in spite of his entreaties to the contrary. It was one of the cruel terms of his stepmother Kaika that Rāma should wear only clothing made from jungle fibre, before leaving the capital. According to the Hindu religion, a virtuous wife must share both the joys and sorrows of her lord. Consequently Sīta followed the example of Rāma, and wore the same kind of clothing. They then left the capital, amidst the loud lamentations of the citizens. During their wanderings they met some Gadaba women, who mocked and laughed at Sīta. Whereupon she cursed them, and condemned them to wear no other dress but the cloth made of fibre.

DISCUSSION.

Sir WILLIAM LEE-WARNER remarked that Mr. Thurston's interesting and able paper, with its excellent illustrations, possessed a double value, for the historian of the past and for the statesman who had his part to play in the present. The materials for Indian history were so scant that the chips from the workshops of every man of science were of the greatest importance. One explorer brought a coin, another an edict graven on stone, a third interpreted architecture, and a fourth cut into a tumulus, and now the lecturer had shown that the human remains discovered in sepulchral jars might help us to say what manner of man once carried that skull and whence he came in the migrations of old time. All these threads helped to guide us to some knowledge of the men of old, their habits, and their lives. Chiselled teeth, a round or a long head, these and other hints enabled the anthropologist to confirm or correct the theories based on pottery, art, or architecture. But perhaps the most important lesson which the paper suggested was that which the administrator of India might learn, and this led the author to recommend that the selected candidates for the Civil Service should be instructed in anthropology. The camel, however, could not bear more than a certain load. In his year of probation the civilian, exhausted by the strain of competition and his University studies, could only go through a limited course, and languages, law, and other subjects must be his first care. But there were others in this country who were more and more using their positions to control and direct Indian administration. On them such a paper as they had just heard might exercise a salutary influence. It might give pause to theorists who looked upon the peoples of India as one nation, or on the requirements of her various races as simple and uniform. It might be well if our legislators could have seen the types of large sections of the Indian community which had been thrown on the screen and drawn their own conclusions. The Indian Section of the Royal Society of Arts was endeavouring to provide in each season one or more papers upon the various classes and sections of the Indian population, and Mr. Thurston's contribution to the series would be regarded as one of high value by those who had had the pleasure of hearing it and seeing the photographs that so clearly illustrated the paper.

Sir JAMES THOMSON, K.C.S.I., said that while the paper, like the author's numerous and famous reports, contained excellent anecdotes and information, which were very entertaining and scientific in their way, it did not contain exactly what he was most in search of. Being a busy man, he wished to be provided, at short notice, with cut-and-dried judgments or conclusions on the subject, something for immediate use. With regard to the matter of hook-swinging, he remembered thirty-seven years ago, when quite a young man, straying into a village in the district of South Arcot, and finding a festival in active operation. The unfortunate man had the flesh of his back softened by the instrument to which Mr. Thurston referred, and the hooks were then inserted, one on one side of the back and the other on the other. He remembered feeling very uncomfortable when he saw the blood trickling down the man's back, although the man seemed perfectly happy. He had never had the good fortune to see the Periyapalayam festival during its progress; but he could not help feeling sorry for the destruction of the large quantities of twigs of the nim tree which were used in decorating the people. He was inclined to agree with the author that it would be a most excellent thing if the young men who went out to administer the British Empire in the East, and even those who engaged in ordinary industrial pursuits, received a training in the sociological and ethnological characteristics of the people amongst whom their life's work was to be passed, but, at the same time, he thought it would probably be better carried out in India than at home.

Sir ARUNDEL T. ARUNDEL, K.C.S.I., agreed with Sir James Thomson's remarks with regard to

the training of men for the Indian Civil Service, although he had not sufficiently studied the subject to put forward definite suggestions. He also agreed with Sir William Lee-Warner's plan of educating Members of Parliament on Indian affairs.

The CHAIRMAN proposed, and Sir WILLIAM LEE-WARNER seconded, a hearty vote of thanks to Mr. Thurston for his interesting paper.

The resolution was carried unanimously.

Mr. THURSTON, in reply, thanked the Chairman for adding another to the many acts of kindness he had shown him while in Madras by presiding over the meeting. His lordship had referred to a trifling monetary loss which he (Mr. Thurston) sustained in a bank smash. Although he did lose a certain amount, he did not lose the whole of the vast fortune which an Uncovenanted Indian official was able to save out of his income, but he thought the state of his feelings at that time and on the occasion of the loss of the coins was sacred to the Club Bar at Madras. Sir William Lee-Warner had referred to his remarks on the subject of training the suckling administrator. Before going back to India he was thinking of taking his discourse down to Cambridge, and inflicting it on the undergraduates there, because they were the men who must be instructed. Sir William Lee-Warner occupied a high position of responsibility, and if that gentleman could arrange matters, he (Mr. Thurston) was perfectly prepared to take his discourse, lantern slides and all, and deliver it before the members of either the House of Commons or the House of Lords! Sir James Thomson, a great friend of his, had charged him with having reached the melancholy stage of anecdotage. He could have dealt with the subject of the paper in two entirely different manners. In the first place, he could have given a great many statistics and technical details, or he could treat the subject in a more popular fashion. He had thought it better to adopt the latter course, as more suitable to a general audience. He had a standing invitation to visit Sir James Thomson at his house, and when he did so he was prepared to puzzle him by discussing anthropological problems with him.

THE COST OF LIVING IN FRENCH TOWNS.

The Board of Trade has followed up its investigations in the cost of living to the working classes in towns of the United Kingdom and Germany, by a similar investigation of thirty French towns, inhabited by people occupied in all sorts of industries. The result of the enquiry is a valuable collection of facts, but it is very necessary to bear in mind the observation of the report itself, that "International comparisons of this nature are full of difficulties arising from differences of national habits and tastes, and from varieties of national organisation, and therefore comparisons based on statistic data alone, must always be read as subject to limitation by conditions which it is impossible to measure statistically." There is abundant proof in this Blue-book of the great difficulty of making trustworthy comparisons between England and a foreign country, in these matters. For example, the report gives prominence to the large percentage of the French working-classes who live in a single room, as compared with the same classes in England and Germany. The tables show that, while in England and Wales dwellings of four and five rooms are the most usual amongst the working-classes, and in Germany dwellings of three rooms, in France tenements of two and three rooms are equally frequent, and tenants of a single room, which were not of sufficient importance to tabulate either in England or Germany, are characteristic of working-class housing in more than half the French towns visited; but in considering this statement two facts have to be borne in mind: the most typical sizes of rooms occupied by working-class families in England and Wales lie between 100 and 150 square feet in area, whereas in France they are between 120 and 200 square feet, and whereas the French rooms are considerably larger than the English, the French household is much smaller. But the difference of accommodation is relatively greater than the difference in the size of the household would warrant, and the smallness of the number of children cannot serve entirely as an explanation of the large number of single room dwellings. Take again the question of house rent, which is such a vital item in the English workman's budget. The figures quoted show that French rents are much lower than English. They are just over three-fourths of the rents of London tenements, but whilst in England the landlord usually pays the rates and recoups himself from the tenant, the rates being approximately 18 per cent. of the gross rent paid in English industrial towns, the French tenant does not as a rule appear to include any element of local taxation, nor has he to pay water rate, as water appears to be freely available to him as a rule, even though it may have to be fetched from the street. If local taxation be excluded from both sides of the account, the Frenchman pays about 2 per cent. less than the Englishman for the same number of rooms.

As to wages and hours of labour, the French workman would appear to be at a distinct disadvantage as compared with Englishmen. Judging by the policy of wages agreements, *i.e.*, agreements made between employers and employed, and established for a particular industry throughout a prescribed area, the rates of wages seem to have made little progress in France, a fact which is probably due to the comparative weakness of trade unionism in most of the towns.

But it is quite plain from the information collected that the Frenchman works longer hours for smaller pay than the Englishman. The report estimates that, taking the building trades, engineering trades, and printing trades, the hours of labour of the French artisan are from 13 to 23 per cent. higher than the hours of labour usual in this country amongst corresponding classes of workpeople. The weekly wages in France for the trades considered stand to English weekly wages for the same trades approximately as 75 to 100, the corresponding ratio for Germany being 83 to 100. The comparison is based on a limited number of trades only, so that there is room for doubt as to how far the conditions in such trades may be taken as generally typical of the conditions in France; but, while it is not possible to make exact comparisons of wages in other trades, the data given in the detailed reports tend to confirm the general impression that rates of wages are, with few exceptions, relatively low in France.

On the whole the Frenchman seems to feed himself better than the Englishman. Taking a man with a weekly income of 25s. and under 30s. in the United Kingdom, 3s. 4d. of it would go on food and drink per head, excluding alcohol; in Germany 3s. 9d., in France 4s. 3d. Considered as a whole, the dietary of a French working-class family is much more varied than that of the British family possessing the same income, and when allowance is made for the smaller number of children in France it is also relatively greater in quantity. The *per capita* consumption of bread, of meat and and fish, of eggs, of butter and other fats, and of potatoes, is distinctly higher, and of all vegetables and fruit very much higher than that shown by the British Budget, while that of milk is slightly higher. Sugar is the only item of which the consumption is much less in France than in England.

The conclusion arrived at by the report is that if the prices of rents in England were changed to their respective levels in France, the expenditure of the average British artisan would need to be increased by nearly one-seventh to enable him to maintain the same standard of life. The weekly money wages of the working-classes in the trades it has been possible to compare with similar ones in England are as 75 to 100; the average usual working hours as 117 to 100; and the hourly rates of money wages as 64 to 100. The basis of this estimate, however, is limited by the fact that the wages and hours of labour which it was possible to compare were only those of the various sections of the building and engineering trades and one section of the printing trade. It must also be remembered that the comparison of prices could not be extended to all the items of the British Budget, and that the comparison of food prices is made from the standpoint of the British artisans' ordinary dietary and not from that of the French dietary. The cost of the ordinary French family budget at French prices will not bear to its cost at English prices so high a ratio as 118 to 100.

THE INDUSTRIES AND RESOURCES OF EASTERN BENGAL AND ASSAM.

A very exhaustive report on the above subject has just been issued from the Shillong Government Press. It is from the pen of Mr. G. N. Gupta, M.A., of the Bengal Civil Service, and contains a detailed review of the various industries of the province, concluding with a summary and suggestions for their improvement and development. The industries themselves are too numerous to specify, but they may be briefly classified as consisting of textile, metal, and leather industries; carpentry, pottery and earthenware; artistic handwork; and agricultural, forest, fish, mineral and miscellaneous industries. When we mention that the above review covers a hundred closely printed foolscap pages, its elaborate nature will be understood. From a practical point of view interest naturally centres on the summary and recommendations for reform, and in approaching this part of the subject, the author makes some preliminary remarks of importance. The indigenous industries of India are decadent, and those which have sprung up instead during the last twenty years have been promoted by foreigners with imported capital, and the profits are remitted abroad. The management and direction are not in Indian hands, and no fund of experience is being accumulated in the country to enable further progress to be made. Among the chief reasons which militate against large industrial enterprise being undertaken by Indians may be mentioned the insufficiency of fluid capital and the want of trained labour. For some time to come such Indian capitalists in Eastern Bengal and Assam as do come forward are recommended to get expert supervision from more advanced parts of India, or, better still, engage properly qualified and competent Europeans.

The province itself is one of the least advanced, so far as industrial progress is concerned. There are no cotton-weaving mills worthy of the name, no cotton-spinning mills, no jute-manufacturing mills, neither wool nor paper mills, glass factories nor pottery works. The exports of the province are also all in raw materials; there are no large industrial centres—like Madras, Cawnpur or Calcutta—and out of the sixty-two larger towns of India, East Bengal and Assam possesses only one (Dacca) with a population of over 50,000 souls. There is a discouraging increase of opium consumption among the indigenous population of Assam, and even agriculture is not very flourishing there. Eastern Bengal is by far the most progressive part of the province; the majority of the population are Mohammedans, and a virile and strongly constituted race, while among its Hindus are to be found some of the most skilful artisans in the whole of India. Here, thanks to jute and the natural advantages of the land, agriculture is in a more prosperous state than elsewhere in India. There is, however, a general desire on the part of the people to encourage and patronise their own manufactures, as well as a desire on the part of moneyed

people, and the middle classes, to engage in industrial enterprises. As to the advent of the literary classes in the field of industry, the following remarks by Mr. Gupta are worth quoting:—"When I saw two young men, who had both passed the entrance examination, going through all the dirty manual work of unhairing leather in a Dacca factory, I was very agreeably surprised. A hosiery firm in Dacca is being worked by a young graduate, whose father is a well-to-do pleader. In Bogra, I met with a graduate who had settled down comfortably as a dealer in rice and jute. The new industry of button-making in Dacca is being largely pursued by men of the higher castes."

Taking the situation as a whole, the outlook is by no means discouraging, especially when one bears in mind, in addition to the foregoing facts, the mineral and agricultural resources of the province, and the various waterways and other communications which afford facilities for trade.

The chief recommendation for improving the present state of things consists in the creation of a separate department to deal with industrial questions and control technical education, a course which has been already adopted in Madras, Bombay, and by other Local Governments. The functions of the department will be, broadly speaking—(1) educational, (2) commercial, and (3) administrative. Its educational duties will be to organise and maintain a system of central and local technical and industrial art institutions in the province; its commercial functions will be to pioneer new industries, and by rendering financial assistance, and by other means to encourage private enterprise; while its administrative functions will consist in the difficult task of securing a co-operation of the people by the creation of industrial committees or bureaux, or similar institutions, and in the establishment of co-operative credit societies among the artisans. Government, it is suggested, should actually pioneer some selected new industries, as has been done in Madras, and (to go further afield for an example) in Japan. In the last-named country after the Restoration, the new Government systematically encouraged the use of Western methods, setting the example by establishing a model filature, a silk spinning mill, a woollen factory, a cotton spinning mill, a cement factory, a glass factory, a paper mill, and other model workshops, besides lending money for the purchase of the necessary plant. In time, as these enterprises were taken up by private individuals, the Government began to sell its own factories.

The most promising future industries in Eastern Bengal and Assam would appear to be—(1) The tanning of leather and manufacture of leather goods; (2) the manufacture of sugar; (3) power mills for silk weaving; (4) power mills for spinning and weaving cotton; (5) tobacco manufacture; (6) match factory; (7) paper mill; and (8) lac factory. Besides these there are numerous other industries of a somewhat minor importance, including such items as enamelled ware, glass, soap, tiles, and preservation of vegetables and animal products; regarding these careful inquiries might be made, and if favourably reported on, they might be set on foot experimentally.

Mr. Gupta concludes his report with several extracts from the speeches of Sir Arthur Lawley and the more elightened leaders of native Indian opinion, all tending to prove that the Swadeshi movement has been running on the wrong lines, that boycott by itself can never solve an industrial problem, and that the realisation of political ideals is to a great extent, if not wholly, dependent upon India's progress as a nation in the paths of useful knowledge, industry, and commerce, as well as co-operation.

ARTS AND CRAFTS.

Exhibition of Work from London Technical Institutes.—It is a good plan to show from time to time the work executed in the various technical institutes aided by the London County Council, and the Whitechapel Art Gallery is in many ways an excellent place for the exhibition. If its lighting arrangements are better suited for pictures than for craft work, it is still possible to see most of the exhibits fairly easily, and its topographical situation is admirable—not too far east to be accessible to people who live in the west and yet on the fringe of a district inhabited by large numbers of wood-workers, jewellers, and other craftsmen whose trades are connected with art. The works collected at Whitechapel were not all of them of very recent date (the vividly-coloured little embroidered triptych from the Clapton and Stamford-hill School of Art, for example, took a gold medal at National Competition two or three years ago), but they represented very fairly what is being done in at least four crafts—woodwork, jewellery, house-decoration, and embroidery. Was it chance or design which happily arranged that of the crafts most fully represented, two should be largely taught and practised within a short distance of the gallery while classes in the other two are rather to seek in the neighbourhood? Anyway by this means the dwellers in the East-end have the satisfaction of seeing that the metalwork turned at Aldgate by the Sir John Cass Institute is at least as good as any produced in other parts of London; and they can also feel pride in the excellent wood-work, ranging from simple carpentry to very complicated joinery from the Shoreditch Technical Institute and elsewhere—though they will have noted, if they are wise, that the best wood-carving comes from the West-end. It is rather a pity that the East-end woodworker should not be taught to do really well the sort of simple carving which lends itself to the decoration of furniture.

The large show of embroidery, coming from nearly all parts of London, emphasises the fact that embroidery classes are scarce in East London. Yet, surely there must be many a trade embroideress, say,

of military decorations (not to mention dressmakers), who would benefit as much by instruction in more all-round work as does, for instance, the trade jeweller. The embroidery covered a very wide field, and showed very plainly how much more methodically the craft is taught than it was a few years ago.

The little collection of work executed in the classes for house painters and decorators was also encouraging. The positive bad taste which characterised the productions of some years back seems to be steadily decreasing, and a very fair proportion of the exhibits at the East London Art Gallery showed, if no very great artistic feeling or promise, yet a certain taste and refinement which mark a decided advance. There was nothing very wonderful about the exhibition at Whitechapel, but it certainly did show, as local exhibitions of a similar nature have shown on a smaller scale, that the work being turned out in the technical classes under the London County Council is surely and steadily improving in quality.

A New Banner for Malvern Priory Church.—A really noteworthy banner has just been presented to the Priory Church at Great Malvern. It has been specially designed by Mr. J. N. Comper, after the old Prior's seal, and executed in the workroom of the Wantage Community, under the direction of Sister Dora. Modern church banners are not generally very interesting either in design or workmanship, but the one just dedicated at Malvern is a marked exception to the rule. Not only has nearly every detail of the restrained Gothic design been planned by the donor and the designer to contain some reference to the history of the Priory, but the embroidery is peculiarly fine. Instead of being of the ordinary shape, the banner, made to the dimensions of the famous Oriflamme of Conrad of Halberstadt, is practically a square with pendant tabs. The ground is formed of alternate strips of murrey and blue damask (the livery colours of the house of York), so equally balanced in weight that there is no unpleasant effect of stripiness. The main subject consists of a seated figure of the Madonna with the Holy Child, supported on either side by St. Michael (the patron saint of the Priory), and St. Martin of Tours (patron of another church held by the monks of Malvern) and, since kings of both houses were munificent donors to the foundation, the figures are encircled by an embroidered wreath of York and Lancaster roses. The brilliant greensward in the foreground dotted with flowers of varying hues, serves the double purpose of helping the colour scheme and of drawing the figures together, so that, in spite of the dividing tendency of the striped ground, they form a compact subject within their circular frame. In each of the pendant tabs is an heraldic shield bearing arms connected in some way with the history of the abbey: the arms of Edward the Confessor, who granted its first charter; the arms of France and England quarterly; the arms of the dioceses of Worcester and Gloucester, in which the possessions of the priory lay. These shields are well worth looking at for the vigour with which the martlets, lions, &c., are executed—very unlike the dull commonplace of so much modern heraldic work.

The four figures are carried out entirely in stitchery—the faces and part of the drapery in floss, the rest in *nué* gold work. They are, of course, Gothic figures, simple and severe, such as it is possible to execute satisfactorily in needlework; and not only are they worked with delicacy and feeling, but the drawing is very well preserved. The stern, ascetic face of the elderly St. Martin is remarkably well rendered, while the wings of the archangel (a peculiarly gentle St. Michael, by the way) in gold and blue and green floss, veined with the merest touch of silver passing, are a beautiful piece of colour and of workmanship. The stitchery is very fine, and not only bears but demands close inspection—but none the less the design tells well at a distance. The whole production, though too strictly mediæval in feeling to be really characteristic modern work, is worthy to go down to posterity as a twentieth century addition to the treasures of the Priory church at Great Malvern.

Recent Metal Work and Jewellery.—Metal work, and more especially jewellery and silversmiths' work, is the branch of artistic craftsmanship which for some years past has, perhaps, more than any other, been most universally pursued by the amateur and by the artist-craftsman. It is really rare now-a-days to come upon an exhibition which does not include a case or two devoted to silversmiths' work of some kind. Other crafts, such as leather work, bookbinding, and embroidery, are often represented, but metal work is always there; and, though there is still too much amateurish jewellery and badly-hammered copper work about, as well as a certain amount of streaky, rather unhappy-looking enamel, the cases scattered about the rooms of the London galleries at the present time contain, for the most part, workmanlike productions quite worth looking at—and at times real works of art.

The Exhibition of Fair Women at the New Gallery, besides affording an opportunity to show Mr. Charles Conder's paintings on silk and gauze, which have attracted so much attention of late, offered, by its very title, a home for the show of jewellery. As a matter of fact, there were only two cases of it—a small one containing tasteful necklaces and pendants by Mr. and Mrs. Gaskin, and a larger one devoted to the work of Mr. H. Wilson. The most interesting objects in this case from the point of view of workmanship were two large hair combs decorated with silver work and little plaques of *plique à jour* enamel. The position in which a comb is worn in a woman's hair naturally allows its ornamentation to be seen pretty frequently against the light, and so gives excellent scope for the display of transparent *plique à jour*; and the workmanship on Mr. Wilson's combs, which is of the delicate kind, met with in old

work, and not to be compared with the beautiful but less carefully finished modern Scandinavian enamelling, deserves to be shown to advantage.

The Lyceum Club generally has some jewellery amongst the objects on view in its Arts and Crafts room, and at the present time the show includes the handiwork of most of the best women jewellers. The work of Miss Kirkman is always interesting; whilst that of Mrs. Roscoe Mullins, who has been turning her attention with very happy results to buttons and sleeve links in silver without stones, is very well worth looking at. Another gallery which, amongst a large quantity of pictures found room for the display of some jewellery and silversmiths' work, was the Grafton. At the exhibition held there by the Ridley Art Club there was a small case of Miss Ramsay's jewellery, as satisfactory in design as it was excellent in workmanship, and a very much larger case devoted to jewellery and silver and copper work by Mr. Nelson Dawson. The exhibits in this case ranged from the lightest of light jewellery, all aglow with brilliant translucent enamel, to heavy copper and steel candlesticks ornamented with opaque *champlevé* enamel rather after the manner of some of the old English brass work at the Victoria and Albert Museum. The colour of the translucent enamel on the chains is quite beautiful, but the plaques of the same material used to decorate some of the vases are less satisfactory. One of the most pleasing of the larger pieces of work was a hot-water jug after a model not very far removed from an old-fashioned French *bouillotte*. Altogether Mr. Nelson Dawson had got together a little collection admirably fitted to show the compass of his work.

CORRESPONDENCE.

DEW-PONDS.

I have seen Mr. A. E. Carey's letter which appears in your issue of the 26th ult.

I an not aware that White, of Selborne, made any "luminous" notes on the subject of dew-ponds; the phenomenon of the water remaining in the pond without any visible supply was perplexing to him, but his notes can hardly be called "luminous."

The point, however, which interests me in Mr. Carey's letter is that he would not commend the method suggested by myself to those who are anxious to obtain a water supply by means of a dew-pond, and he thinks that he can suggest a better plan. Doubtless he is referring to the patent method, about which he spoke in a former letter to the *Journal*.

I may at once say that I have no axe to grind. My only desire is that the best condensing surface should be made known, and that its cost should not be a prohibitive one. Assuming that this is also Mr. Carey's desire, I beg to make the following proposition:—

That he and I, on some spot to be determined, should each construct a condensing surface, having the same area, the limit of cost of the respective methods to be within 10 per cent. of each other, and that neither surface is to be mechanically chilled, but that both are to work automatically.

The methods adopted, and the results obtained by condensation, are to be the measure of the merits of the respective surfaces, and the methods and results are to be published in the Royal Society of Arts *Journal*. Each party is to pay the costs of his own experiment, and to share such costs as may be common to both.

George Hubbard.

QUESTIONS AND ANSWERS.

NOTICES TO CORRESPONDENTS.

On all communications must be written the name and address of the sender, not necessarily for publication, but as a guarantee of good faith.

Each question or reply should be written on a separate sheet of paper, and should bear such signature of the writer, and such address as he wishes to appear.

Questions which can be answered from the usual books of reference, will not be printed.

QUESTIONS.

Cuir Bouilli.—This method of treating leather is described as a lost art in all books on leather work which I have had an opportunity of consulting. Can any reader inform me where a description of the process can be found, or give information on the following points:—Is the leather (cowhide) used for embossing suitable for *cuir bouilli*? Is the leather boiled in water, or are any, and what, ingredients added? Is any part, more particularly the incising of the outline, of the work done before boiling? If not, what means are used to keep the leather soft after boiling for a time sufficient to allow the incising and modelling to be carried out.—E. H.

The River Orange.—I should like to know what English, French, or American geographical accounts there may be of the river Orange (South Africa)? Of English war literature and school books I have knowledge, but I can trace no thorough geographical paper.—Edwin A. Walford.

ANSWER.

Japanese Waltzing Mice.—I think it is the generally accepted theory that these mice originated from ancestors with diseased brains, and that continual inbreeding has established a fixed variety. The waltzing is, no doubt, due to a defective brain. Excessive inbreeding of the ordinary species of mice will bring about a similar result.—Mrdicus.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock :—

APRIL 28.—"The Resources of the Peruvian Andes and Amazon." By C. REGINALD ENOCK, F.R.G.S. SIR CLEMENTS ROBERT MARKHAM, K.C.B., D.Sc., F.R.S., will preside.

MAY 5.—"English Furniture Design and Construction." By PERCY A. WELLS.

MAY 12.—"The Principles of Heredity as Applied to the Artificial Production of new forms of Plants and Animals." (Aldred Lecture.) By PROFESSOR ARTHUR DENDY, D.Sc., F.R.S., F.L.S.

MAY 19.—"Railway Development in China." By ARTHUR JOHN BARRY, M.Inst.C.E.

MAY 26.—"The Manufacture of Nitrate of Lime from Atmospheric Nitrogen." By SAM EYDE.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

APRIL 29.—"The Problem of Indian Labour Supply." By SELWYN HOWE FREMANTLE, I.C.S. The RIGHT HON. VISCOUNT MIDLETON, late Secretary of State for India, will preside.

MAY 13.—"Some Phases of Hinduism." By KRISHNA GOBINDA GUPTA (Member of the Council of India).

MAY 27.—"The Function of Schools of Art in India." By CECIL L. BURNS, Principal of the Bombay School of Art. PROFESSOR SIR HUBERT VON HERKOMER, C.V.O., D.C.L., R.A., will preside.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock :—

APRIL 20.—"South Africa." By the HON. CHARLES GIDEON MURRAY. LORD BRASSEY, G.C.B., D.C.L., LL.D., will preside.

MAY 18.—"Canada as a Field for British Investment." By J. OBED SMITH, Assistant Superintendent of Emigration, Department of the Interior, Canada.

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

F. W. LANCHESTER, "Aerial Flight." Three Lectures.

LECTURE I.—APRIL 26.—The principles of dynamic support—The action of an inclined plane—The law of pressure reaction as a function of velocity—The law of pressure as a function of angle—Frictionless flight—The law of power expenditure as based on the laws of the pressure reaction—The laws of pressure reaction and power expenditure quantitatively considered: a discrepancy—The dipping front edge and its lesson—Cyclic motion in its relation to the supporting reaction—Direct evidences of cyclic motion—The quantitative treatment on the hypothesis of a cyclic component—The power expenditure under real conditions—Skin friction, its nature and magnitude—Skin friction as affecting power expenditure—Skin friction and other factors as limiting the wing area—Aeroplane *versus* pterygoid form—Meaning and influence of *aspect*—Importance of aspect ratio—The gliding angle, as measure of resistance—The minimum gliding angle as a function of the velocity of flight—The coefficient of skin-friction and the aspect ratio as affecting the value of the minimum gliding angle—The angle of inclination as related to the minimum gliding angle—The pressure proper to least resistance—The theory of screw propeller efficiency—Comparison of theoretical results with measurements of birds, flying machines, &c.—Controversy as to influence of skin-friction—Conclusions as affecting the problem of mechanical flight.

LECTURE II.—MAY 3.—The principles of stability—The simple glider—The ballasted aeroplane—Form of the flight path as observed—The flight path as plotted from the equation—The phugoid chart and its teaching—Changes of amplitude of the phugoid curve and influences that lead to such changes—Conditions of flight path, stability and the equation of stability—Effects of propulsion on stability—Influence of the flexibility of the aerofoil—Lateral stability—Rotative stability—The stability of birds and of flying machines in practice—Flight path stability desirable but not essential to flight—Steering in altitude and azimuth—Gyroscopic couples—The boomerang—The gyroscope as an aid to stability.

LECTURE III.—MAY 10.—*The Flying Machine.*—The function and uses of the flying machine—Possible types—The conditions to be fulfilled as defining the type—The need for high velocity—The difficulties of high velocity—The horse-power problem—Motors for flying machines and the conditions governing their weight—Fuels available and the relative importance of fuel economy—Propulsion and the propeller—The use of gearing—The limitations of flight as due to the mode of propulsion—Other modes of propulsion—Wing flapping and its efficiency—Soaring—Starting and alighting—Questions of design and construction—Steering and steering mechanism—Flying at a height—The advantages and disadvantages of altitude—Types of flying machine in practice—The future of flight—The flying machine as a mode of locomotion, in peace and war.

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FRIDAY, APRIL 16, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

TUESDAY, APRIL 20th, 4.30 p.m. (Colonial Section.) HON. CHARLES GIDEON MURRAY, "The Road to South African Union."

Further particulars of the Society's meetings will be found at the end of this number.

PROCEEDINGS OF THE SOCIETY.

THE SOCIETY'S EXAMINATIONS.

[In the year 1897 the International Congress of Technical Education held its meeting in London, at the Society of Arts' House. At this meeting a paper on the history of the Society's Examinations was read by the Secretary, Sir Henry Trueman Wood. The paper with certain additions was reprinted in the *Journal* in 1903, and it is now republished with such further alterations and additions as are required to bring it up to date.]

The Society's Examinations are conducted simultaneously at a number of different centres throughout the kingdom, through the agency of local examination committees established for the purpose by the Society. The papers in each subject are sent down in separate envelopes to the secretary of the committee immediately before the day of examination. The envelopes are opened in the presence of the candidates, and the papers distributed. The worked papers are sealed up at once and despatched to the office of the Society. They are then distributed among the various examiners who report upon them, and the results are published.

EARLY HISTORY.

The examination system of the Royal Society of Arts was an outcome of the Great Exhibition of 1851, which, as is well known, was originated by the Society. In November, 1851, Mr. Harry Chester, then a Vice-President of the Society and afterwards Chairman of the Council, submitted to the Council a scheme for the formation of a union of mechanics' institutions, the principal object of which was to encourage the founding of such institutions, and to develop the educational facilities which they provided.

Among the early suggestions for the utilisation and development of these institutions was a proposal for a general system of examinations among their members. In December, 1853, Mr. Chester definitely proposed the establishment of such a system, and in the spring of 1854 a scheme of examinations was published. The scheme was of a very comprehensive character, and included the following subjects:—1. Mathematical Sciences; 2. Experimental Sciences; 3. Sciences of Observation; 4. Mechanical Sciences; 5. Social Sciences; 6. Fine Arts; 7. Moral and Metaphysical Sciences; 8. Literature. This very elaborate programme proved a little impracticable, and it is not to be wondered at that only a single candidate offered himself for examination in March, 1854. The promoters of the movement were not, however, discouraged; the scheme was remodelled, principally by Dr. Booth, at that time an active member of the Society, and in 1856 an examination of 62 candidates was held at the Society's house. The subjects of this first examination were:—1. Book-keeping; 2. Arithmetic; 3. Algebra; 4. Mensuration; 5. Geometry; 6. Mechanics; 7. Chemistry; 8. Animal Physiology; 9. Botany; 10. Agriculture; 11. Geography; 12. Physical Geography; 13. English History; 14. English Literature; 15. Latin and Roman History; 16. French; 17. German; 18. Freehand Drawing.

In the following year, 1857, the first attempt at provincial examinations was made, and an examination was held at Huddersfield, as well as in London, the examiners of the Society going down for the purpose. The desire of

increasing the number of examination centres and the obvious impossibility of sending examiners simultaneously all over the country, led in 1858 to the elaboration of the system of local committees to supervise examinations worked from a single centre.

The College of Preceptors.

The Society of Arts, however, cannot claim the sole credit of the invention of the system of local examinations. In 1850 the College of Preceptors (established in 1846) was considering the best means of examining the schools of its members. It commenced by sending down examiners, its first school examination having been held in December, 1850, at Nottingham, but in 1853 the experiment was tried of collecting pupils to a centre and examining them by means of papers sent down from London. The experiment proving successful, the system was regularly organised in the following year, 1854, and has been continued ever since.

It will be seen that the College of Preceptors' Examinations preceded those of the Society of Arts by two years, but the objects, the conditions, and the methods of the two systems have been so different that there has never been any but the most friendly rivalry between them. In 1856 a conference was held at the Society's house between representatives of the two bodies, the College being rather afraid that the Society's Examinations would interfere with their own. It was soon apparent that the two systems were intended to occupy different ground, and were not likely to affect one another. In practice this has proved to be the result, and it has never been found that they have interfered in the least with one another.

To the Society's Examinations in 1858, 58 institutions sent up 288 candidates; in the following year there were 480; in 1860, 586. The numbers increased steadily till 1865, when there were 1,899; the next year showed a slight diminution, and then there was a further increase, till the number of 2,160 was reached in 1869. This was largest number examined under the original system.

University and Government Examinations.

The University Local Examinations were established in 1858. The establishment of Elementary Drawing Examinations by the Department of Science and Art was about contemporaneous with that of the Society's Examinations. The Science Examinations began later, in 1861, and as these developed, it was found that the Society's Examinations were in many respects competing with those of the Department. The same candidates were being examined in the same subjects, and there was an evident waste of power. In 1870 this led to the abandonment of 17 out of the 36 subjects then included.

Changes in System, 1876.

In 1871, when the Council was considering the establishment of a system of Technological Examinations, of which an account is given below, they passed a resolution to discontinue the General Examinations, but on the application of some of the more important of the Institutions in Union, they rescinded the resolution and determined to continue the examinations for a further period. This was done, on the same system as before, till 1876, when the programme was revised, and the plan on which certificates were granted was somewhat modified. Previously, certificates had been granted for single subjects, but in that year a "Commercial Certificate" was established in addition, to take which it was necessary to pass in, at least, three subjects. Very few of these certificates were ever taken, the system of single certificates for single subjects being more popular and better suited to the needs of the class of students who take up the Society's Examinations.

Proposed Abandonment, 1879.

In 1879, the question of abandoning the Examinations again arose, it being thought that the ground was covered by other agencies. To quote from the report of the Examination Committee in 1879:—

"The Committee feel that the time has now come when the Society should cease to compete with other educational agencies more influential in the work of examination. With the Education Department examining millions of children in elementary schools, and thousands of young persons in night classes; with the Universities holding their local examinations throughout the country, for young persons of a higher class; with the Science and Art Department examining students in every branch of science and art; with the new City Institute developing yet further the Technological Examinations just handed over to them by the Society; with other agencies, such as the College of Preceptors, doing kindred work, the Society of Arts may well retire from the field, having in all these various directions acted as pioneer. It held science examinations before the Science Depart-

ment, examinations in literature before the Universities went afield to meet the classes who could not go to Oxford or to Cambridge. It has seen the system it established develop, with the aid of Government funds, as it could never have grown without such help, and the time has now arrived when it may cease to compete with the agencies it has done so much to foster."

The System Re-modelled, 1882.

In pursuance of the course mentioned in this report, no examination was held in 1881, but again, some of the institutions where the examinations were held protested, and on further consideration it was determined to continue the Examinations, but to try whether they could not be made self-supporting. Hitherto they had been free. In 1882 a fee of 2s. 6d. was charged to each candidate, and this charge has since been continued. The "Commercial Certificate" was abandoned and the old system was resumed of giving a separate certificate for each subject. The natural result of fees being charged was a considerable falling off in the numbers examined. In 1882 only 695 papers were worked as compared with 2,325 in 1880. The numbers, however, soon began to increase again. In 1890 there were 2,474; in 1895, 5,108; and in 1900, 9,808. This very considerable increase was doubtless, to a very great extent, due to the facts that the London County Council had, by the Technical Instruction Act, 1889, been placed in possession of large funds available for the promotion of technical education; and that certain commercial subjects were scheduled by the Science and Art Department as subjects coming within the scope of the Act. The commercial subjects so scheduled were precisely those in which the Society of Arts examined.

Elementary Examinations.

In addition to its Commercial Knowledge Examinations, the Society conducted, from 1856 to 1894, Elementary Examinations. These were really carried on by District Unions and Local Boards in connection with the Society. All the Society did was to supply identical examination papers, the results being examined and certificates awarded by examiners appointed by the Local Boards. The Society supplied the certificates, but accepted no responsibility as to their award. The system, though useful at its first establishment, was never found to work in a very satisfactory manner, and in 1895 it was abandoned.

There was, however, always a demand for examinations of a more elementary character than the general examinations, and in consequence elementary examinations in modern languages (French, German, and Spanish) were established in 1897. These were fully appreciated, and eventually, in 1901, an Elementary or Preliminary Grade was added. The subjects selected for this Grade included Handwriting and Correspondence, Shorthand, Book-keeping, Arithmetic, Typewriting, Commercial Geography, French, German, and Spanish. In the first year in which the Elementary Examinations were held (1901), there were 4,458 papers worked in the different subjects, of which 2494 passed and 1,964 failed. The percentage of successes and of failures was, therefore, 56 and 44. There has since been a continuous growth, till last year (1908) the numbers reached 9,811 with a percentage of 64·35 successes and 35·55 failures. It may, therefore, fairly be concluded that the increased numbers have been accompanied by a slight improvement in quality.*

Present System Started in 1905.

In 1905 some considerable modifications were made in the Programme. In the system existing in 1904 there were two grades—Senior and Junior. In the Senior there were three classes, and in the Junior, or Elementary, one. For some years past suggestions had been made from various quarters to the Council that it would be desirable to establish a higher grade of examination, which might be taken by more advanced students than those entering for the examinations as they then were. After very careful consideration, and a good deal of correspondence with the local committees, it was determined that the examinations should be arranged under three stages. Stage I. was to be Elementary; Stage II., Intermediate; and Stage III., Advanced. The Elementary was to be as before, a pass examination, and in each of the two upper Stages there were to be two classes. It was proposed that the Advanced Stage (No. III.) should practically correspond with the First-class of the old Grade II. and the upper part of the Second-class, while the idea was put forward that the standard should be very gradually advanced. The Intermediate Stage was made up of the Third-class and the lower part of the old Second-class of Grade II.

* During the preceding ten years, no changes of importance were made. Domestic Economy, which had been in the Programme almost from the beginning, was dropped in 1901.

This system has since been carried on without any alteration, and it has been found to work very well. The advance in the standard has been very trifling, as it was found from the general character of the papers sent in that any considerable elevation of the standard would involve an undue amount of rejections, that is to say, more than a third of the candidates entering. Some new subjects were also added to the Advanced Stage, the principal of which were Commercial Law and Accounting and Banking. A slight change was also made in the fees, those for the Advanced and Intermediate being left as before at 2s. 6d., and for the Elementary Stage the fee was fixed at 2s., with a reduction of 1s. for every subject after the first subject taken up.

The new system resulted in a very large increase of candidates, from 17,771 in 1904, to 21,253 in 1905. This total gradually grew to 22,597 in 1908. In the present year there will be a still further increase, but the precise number is not yet known.

In 1907, at the request of the Army Council, it was arranged that a special annual examination in Shorthand should be held for soldiers at any centre fixed by the Army Council throughout the Empire. Last year (1908) a similar examination was arranged in Typewriting.

Value of the Certificate.

As regards the practical value of the three sets of certificates, it may safely be said that a certificate of the Advanced Grade (especially of the First-class) may be taken to afford an employer a reasonable assurance of a competent knowledge of the subject (so far as it can be tested by examination) on the part of a candidate for employment who presents it. A certificate of the Intermediate Grade may be taken as evidence that the person presenting it has made a study of the subject and has made some progress in that study. An Elementary certificate in the hands of a young person shows that special study of the subject has been attempted, and its successful pursuit looked forward to in the future. It must be remembered that this grade is only intended for young persons of, or just over, school age.

Viva Voce Examinations in Modern Languages.

A question which had been for a long time before the Council was the holding of *vivâ voce* examinations in Modern Languages, and as far back as 1870 suggestions, made by the late Mr. Hyde Clarke, for holding such examinations locally, were included in the programme. Nothing, however, came of these suggestions. It is quite obvious that no paper examination can be an adequate test of knowledge of a spoken language; but the difficulties connected with the holding of colloquial examinations simultaneously at a number of different centres for a long time proved insuperable. In 1902 the idea of holding such examinations at the same time as the other examinations was abandoned, and it was announced that examinations in French, German, and Spanish would be held at any date at any of the Society's examination centres where proper arrangements could be made. Portuguese and Italian have since been added to the list of subjects. The experiment proved very successful. In the first year 280 candidates were examined. The numbers rose to 681 in 1905. Since then there has been a slight falling off. Last year (1908) there were 615. The percentages of success and failure in 1902 were 72·2 and 27·8. In 1908 they were 76 and 24. This points to improvement in the preparation of the candidates. It is found on the whole that nearly all the candidates who entered have a very fair colloquial knowledge of the language, while certificates of distinction have been granted to a great many who have shown thorough proficiency. No difficulty has been experienced in conducting the examinations satisfactorily, thanks to the energy and ability of the gentlemen whose services as examiners the Society have been successful in securing.

Technological Examinations.

The Technological Examinations, referred to above, were instituted in 1873, at the suggestion of the late Sir John Donnelly. These examinations were intended to test the knowledge possessed by artisans of the subject-matter of their respective industries. It was arranged that they should be held in connection with the May examinations of the Science and Art Department, the technological papers being given out with those of the Department. Before a candidate could obtain a certificate, he was required to pass a Department examination in certain specified science subjects, these varying according to the technological subject taken up. Certificates of three grades were given, elementary, advanced, and honours, corresponding with those of the Department examination. No attempt was made to test practical skill, but

each candidate was required to produce a certificate from his employer in which his competence was stated. The number of candidates was never great. In the first year (1873) only six entered and the numbers gradually increased to 68 in 1870, and 184 in 1878.*

In 1879, on the foundation of the City and Guilds of London Institute, the Technological Examinations were handed over to that body. From the funds placed at its disposal by the City companies the Institute was able to offer to teachers payments on the results of the examination like the grants of the Science and Art Department. Teachers were thus enabled to form classes and to send pupils in for the examination, and a large increase in the number of candidates took place. These examinations now form an important part of the Institute's work, and attract annually a very large number of candidates. In 1908 the number examined was 22,458. Large additions have also been made to the list of subjects, which now number 75. No great change has been made in the general character or system, which remains much the same as that proposed by Sir John Donnelly, but the details have been considerably modified, and in some cases a practical examination, to test handicraft skill, has been provided.

Examinations in Practical Commercial Knowledge.

In 1889 an attempt was made to establish a system of examinations in "Practical Commercial Knowledge." Syllabuses for two subjects, "The Commerce of Food" and "The Commerce of Clothing," were issued, but no candidates came forward, and after a second year's trial, the proposition was dropped.

Practical Examinations in Music.

In 1879, at the suggestion of Dr. Hullah, examinations in Practical Music were established, that is to say, examinations at which the actual capacity of students to play an instrument, or to sing, could be tested. It was intended that these examinations should apply to a less advanced class of candidate than those who entered for the well-known examinations of the Royal Academy of Music, at the time when the Society's system was started, or who now enter for those of the Associated Board of the Royal Academy and the Royal College of Music. It is believed that the Society's examinations have fulfilled their purpose, and have proved a useful means of encouragement to many musical students. Dr. Hullah acted as examiner from 1879 till his death in 1884, and was succeeded by Mr. W. A. Barrett, who died in 1891. The work was continued by Sir John Stainer, Sir Joseph Barnby, and Mr. W. G. McNaught. In 1895 Mr. John Farmer was appointed, and he continued to act till 1899, when he was obliged to give up the work in consequence of illness, which, at a later date, terminated fatally. The examinations are now conducted by Dr. Ernest Walker and Mr. Burnham W. Horner, who served as Assistant Examiners to Mr. Farmer. The numbers examined have never varied within very wide limits. In the first year there were 117 candidates. The numbers increased gradually to 276 in 1891, and to 393 in 1895. The largest number yet examined was 566 in 1900. During the last few years there has been a small but steady diminution. The standard has not varied greatly, but is now a little higher than it was. The general level of attainment is reported by the examiners to be slightly higher of recent years.

Conclusion.

It will be seen that the development of the examinations of the Society during the half century covered by this account has been very remarkable. The 62 candidates who took part in the experimental examination of 1854, had increased to 2,325 in 1880. The abandonment of the examinations in 1881 caused a great falling off when they were renewed in 1882, but, giving round figures only, the 700 candidates of that year steadily increased to 9,800 in 1900. The Technical Instruction Act of 1899 caused the numbers to shoot up in 1901 to over 13,000, and the changes introduced in 1905 brought the increase in that year up to over 21,000. There has been a slight, but steady, growth in the last three years, the numbers last year (1908) being 22,597, and those for the present year (1909) will show a still larger proportionate increase, though the precise figures cannot as yet be given. The number of centres at which the examinations are now held, is 415. Since 1882, when the

* The following were the subjects included in the 1878 examinations:—Cotton manufacture, Paper, Silk, Steel, Carriage-building, Manufacture of Pottery and Porcelain, Gas manufacture, Glass, Cloth, Silk-dyeing, Wool dyeing, Calico-bleaching, dyeing, and printing, Alkali manufacture, Blow-pipe analysis.

present system started, down to and including 1908, 238,605 papers have been worked.

As to the subject-matter of the examinations, the scheme which originally may be said to have covered pretty well the whole range of general education, except the dead languages, was gradually re-modelled and reduced until it now comprises commercial education alone, with the sole exception of music.

Full details of the present system, with syllabuses and past examination papers in the different subjects, will be found in the Society's annual Examination Programme, while the actual results are given in the lists published by the Society as soon as possible after the holding of each examination.*

THE INTELLIGENCE OF THE ELEPHANT.

The distinction between the reasoning capacity of man, and the instinct or intelligence of animals, is a theme on which much has been written, and which, even now, is in great dispute. Similarly, there is considerable difference of opinion as to which of a group of animals, comprising the horse, cat, elephant, various members of the monkey tribe, parrots, canaries, and even fleas, may be said to stand first in this respect. By general consent, the dog would appear to hold the first place in the arrangement of animals according to their intelligence. But several authorities hold different opinions. Dr. W. L. Lindsay, who has made a highly elaborate study of the "mind in the lower animals," arranges the various mammalia in the following order:—

1. *Bimana*, higher man only.
2. *Quadrumana*, especially the larger anthropoid apes.
3. *Carnivora*, including especially the dog and cat.
4. *Proboscidia*, the elephant.
5. *Ungulata*, especially the horse, mule, and ass.
6. *Rodentia*, especially the beaver and rat.

As a rule the elephant is ranked about third or fourth, by the majority of writers. Cuvier places the elephant in point of sagacity after the dog and some other species of carnivora. Sir Emerson Tennent is much of the same opinion, and Mr. G. P. Sanderson, who has been so long and intimately associated with elephant catching in India, places them in respect of reasoning faculties far below the dog and some other animals, adding that the former are "decidedly wanting in originality."

On the other hand, Mr. W. T. Hornaday, who has had practical experience of elephants and who has brought much scientific analysis of the evidence to bear on the subject, considers there is no question of the elephant's *general* intellectual superiority over all other animals except higher man. He would sub-divide the intelligence of an animal into classes, viz.—1. Powers of independent reasoning or observation. 2. Memory. 3. Comprehension under tuition. And 4. Accuracy in the execution of man's orders. Closely allied to these are the moral qualities, such as—(1) Amiability, which guarantees security to his human associates; (2) patience or submission to discipline or training; (3) courage, which gives self-confidence and steadiness; and (4) a disposition to obedience, with cheerfulness.

In considering instances which may come under one or other of these categories, it is undoubtedly fairer not to argue from any particularly intelligent specimen or example of a given race or species, but to consider them as a race or species. This is an argument in favour of extending the basis and range of observation as widely as possible.

One important consideration telling in favour of the elephant, as contrasted with the dog, is that the latter enjoys, as a rule, unrestrained liberty, roaming about through his master's house and premises, both in town and country, and mingling freely with all kinds of men and domestic animals, while the elephant in captivity is chained to a stake, with no liberty of action whatever. And when released from his chain, he is under the complete control of his *mahout*, who directs his every act. There is no telling what wonderful powers of reasoning captive elephants might develop if they could only enjoy the freedom accorded to most dogs.

As for wild elephants, Mr. Hornaday has frequently seen them—(1) reconnoitre dangerous ground, by sending forward a scout or spy; (2) communicate intelligence to each other, by signs; (3) retreat in orderly silence from a lurking danger; and (4) invariably march in single file, like the jungle tribes of men.

Where wild elephants have to be captured by tame ones, the human-like intelligence displayed by the latter in first entrapping and then tying the captives, one by one, in a "Kheddah" is extraordinary. They enter into the business with both spirit and understanding of all the different stages, and as occasion requires will deceitfully cajole or rigorously punish a troublesome captive. In connection with this a curious incident is on record of a female elephant which was purchased at a sale of her late master's effects, without the new owner having the least notion that she was (by profession) a "koomkie" or decoy. The mahout, glad enough to be out of an employment that was fraught with danger, said nothing to his master about the true character of the animal. One morning "Lutch-mee," which was her name, was not to be found, and several days having elapsed without news she was given up for lost. About a week after, Lutch-mee made her appearance as if nothing had happened.

* The Programme for the year, and such Programmes of previous years as are not out of print, can be obtained at the Society's office, price 4½d. each. The results for each year can be obtained at the same place, price, for each Stage, 6d.

and her master mounted her to have a ride. He happened to proceed towards a grassy jungle, which the animal several times tried to enter, but was turned aside each side by the mahout, who was afraid her holiday might have developed in her some wild and dangerous habit or taste. At last Lutchmee grew quite uncontrollable and rushed into the jungle, only stopping at a thick clump of trees, where, to the intense surprise of her master, a large male elephant was discovered, round whose legs, secured in the most approved fashion to four trees, was the iron chain with which Lutch-mee was usually fastened to her own picket at night time. She was resolved to resume her old profession, and had consequently set about carrying on the business on her own account, thus securing one of the finest elephants that had been taken for many years.

With some writers, however, it is still a moot point whether the predominating quality of the elephant is not extreme docility coupled with caution rather than very abnormal sagacity. This is the opinion of several Eastern authorities. One ot these, who had had considerable opportunity of studying the characteristics of elephants, comments in a letter to the writer on the wonderful work these animals do in dragging and sorting timber and in breaking up obstructions caused by logs and miscellaneous flotsam in streams; but in all this he inclines to think it is the strength and obedience to the mahout's orders rather than the innate cleverness of the beast that call for admiration.

In Burma and other parts the timber is got out and floated on the smaller streams and creeks, which are full during the monsoon. The logs are carried down the creeks till they are arrested by a boom at the junction of a main creek, and a navigable, or rather "raftable," river. In the centre of the boom there is a practicable entrance or opening, and through this aperture the elephants are trained to shoot the logs, one at a time, a task at which they get particularly clever, coiling their trunks round the logs, letting them swing in the current till they are "end on," and then propelling them through the opening. The narrator of this incident has seen them break up a jam of thousands of logs, which had got massed together above a bridge, and shoot them all through the openings in the neatest way. For a time the best trained elephant will even work alone on the water, obeying the directions of the mahout, standing on the bank; but, as a rule, a man must sit on the elephant's head, a very wet job, as when an elephant swims only just the top of his head is out of the water.

Certainly in ancient times their intelligence had not struck the great conquerors of Macedonia, Epirus, Greece or Rome as anything very exceptional, for it was their strength and height that chiefly led to their employment in warfare, and also the terror and demoralising effect produced on an enemy unused to such strange monsters. Alexander the Great appears to have been the first European to have used elephants in war, and his successors had even more frequent recourse to them. The Lagidæ and also the Seleucidæ made considerable use of them in their campaigns, and Antipater brought over into Greece the first elephants ever seen in that country. Pyrrhus conveyed some to Italy and employed them in his contests with the Romans, who were thus to some extent familiarised with these creatures even before encountering them in their long struggle against the Carthaginians. The usage of the latter was followed by the kings of Numidia, and Jugurtha had also recourse to elephants, but unsuccessfully, in his endeavours to overcome the legions of Metellus. Also Juba fared no better in pitting them against Cæsar's army. Finally, the Romans themselves adopted them for military purposes, but they never seem to have placed much reliance on their help, on account no doubt of their liability to panic, and definitely abandoned them towards the end of the republic, retaining them solely for displays and contests in the circus and amphitheatre. One of the chief decorations of the great Flavian amphitheatre or Colosseum at Rome was a barrier, or *chevaux-de-frise*, formed of elephants' tusks, about eight feet in length, interlaced in a fence or fret-work of gilt iron. This acted as a barrier against the possible attacks of wild beasts or attempts on their part to leap out of the arena.

During the long and sanguinary struggle between Persia and the empire, elephants made a temporary re-appearance in the armies of the Sassanian kings, particularly in the sieges in Mesopotamia and Colchis. From the fall of the Sassanian dynasty the elephant disappeared as an auxiliary in warfare, except in India, where it continued to play a more or less prominent part in fighting till the universal adoption of fire-arms finally banished it from the battle field. Altogether one can trace the military employment of this beast with approximate continuity through some twenty centuries.

It is interesting to note that during these times the elephant appears to have been far more widely spread than nowadays. Armandi, whose work is a standard authority on the subject, collects a body of evidence tending to prove that the animals were found in plenty in Numidia and Mauritania as far as, if not beyond, the Atlas Mountains. In fact, after the submission of Carthage and conquest of Northern Africa, the Romans symbolised those subjugated provinces by the picture of an elephant or a woman crowned with a head-gear distinguished by a trunk and two tusks. In a similar way Egypt was pictured by a crocodile and Judæa by a palm tree. In our time, India has been symbolised by a Bengal tiger, Australia by a kangaroo, Canada by a beaver and so on.

In the well known Sanskrit epic, the Mahábhárata, as well as in other Sanskrit works, the prominent use then made of elephants for military purposes was indicated by the following figures, which are laid down as those of a model army, viz.: 109,350 in-

fantry soldiers, 65,610 horsemen, 21,870 war chariots, and 21,870 elephants.

In modern times, our occupation of India seems to have inaugurated a great change in the utilisation of the elephant for man's purposes. The invention of firearms had already led to their practical abandonment for battle, except as purely beasts of burden, and it is in training them to act as such, and in developing what is probably the maximum of reasoning power observable in the brute creation, that such remarkable results have been obtained in India.

In accompanying batteries of artillery they have been found very useful, the bullock teams having often proved powerless to extricate a gun from a mud-hole or morass. Captain Walter Campbell tells us that when a gun comes to grief, the elephant marches up with the important air of an experienced engineer, and deliberately inspects the state of affairs. Twisting his trunk round the spoke of one wheel, he gives it a lift, as if to ascertain the depth and tenacity of the mud, and then quietly walks round and does the same by the other wheel, dropping it again with a knowing twinkle of the eye, as if he said to himself, "All right, I can start her, I think." Then he deliberates for a few minutes, gives a slight push here and a slight push there, when, having at last made up his mind as to the best mode of proceeding, he probably applies his forehead (previously padded) to the muzzle of the gun, and, uttering a shrill trumpet-like sound, as a signal for the gun bullocks to pull together, pushes against it with all his weight, while the bullocks obey the signal and pull away too. This generally starts the gun. But if the bullocks are sulky and refuse to obey the signal, the elephant gets perfectly furious, and rushes at them, brandishing his trunk with such ferocity as usually to compel obedience.

Elephants require the greatest care in respect of diet and general attention, as, though they are so strong, they are delicate, and the neglect of certain well understood precautions very soon impairs their health. Habitual work and sound and timely rest—about four or five hours—are necessary for them. When in health they are always in motion, either swinging the trunk, flapping the ears, or moving about. If they stand quite still it is a clear sign they are out of condition or unwell.

They are mainly used for dragging timber in Burma, but some authorities consider they are unsuited for this, as the pressure from the breast bands lies upon the upper part of the chest, which forms the most delicate part of the animal's physique. Pushing timber down stream is, perhaps, the easiest work for which they can be used, and for this they are well adapted, but even then great care has to be taken of their feet, the soles of which are apt to get tender.

Mr. M. J. Slym, of the Burmese Forest Department, was once crossing a small river, in which the water rose to a little above the belly of the elephant. Slipping accidentally from the side to the middle of the stream, the animal suddenly became fixed and unable to move. Men were sent to the rescue, but they could ascertain nothing else but that his feet were surrounded by blue clay, and absolutely immovable. At last, everything having proved fruitless, Mr. Slym caused the stream to be dammed, and the water below to be baled out with native pots, after which the clay, on which the animal appeared to be standing, was removed, when it was found that he was standing upon a solid rock, on which his great feet acted like suckers. With great difficulty, some air was introduced below the soles of his feet, when he soon emerged from his predicament, after a detention of thirty-six hours.

As a rule, so Mr. Nisbet informs me, elephants are very cautious in approaching the banks of streams, and will carefully test the solidity of an earthwork before entrusting their whole weight on it. Similarly, they always try the strength of a wooden bridge, before venturing along it. Mr. Nisbet has only once known a loaded elephant fall, and that was a bad-tempered animal that was trying to throw down its load on a hillside, along which a narrow track led. The load, however, happened to be well tied on, and the result was that it overbalanced, and carried the elephant down the hillside. Elephants swim well, and have often been seen to cross the Irrawaddy in flood, and so ancient an authority as Ælian says they have been seen, at such times, carrying their young on their tusks.

When free, in its native woods, the elephant evinces rather simplicity than sagacity, and the rich profusion in which Nature has supplied its food, ought, one would think, to render it quite independent of all artifice. Indeed, Sir Emerson Tennent goes so far as to say that its intelligence seldom exhibits itself in cunning, but this is certainly incorrect as regards the "rogue" elephants, which, Sir Samuel Baker says, are extremely cunning, and respecting which he relates several characteristic stories. One incident, told to Sir Emerson, seems to disprove his own contention. A recently captured elephant was being led from the corral by two tame ones, when it suddenly began to falter, and at last sank to the ground, and lay there lifeless. The fastenings were removed from its legs, but all attempts to rouse it, or restore animation, failed, so it was decided to abandon the carcase. While the ropes were being removed the narrator and his friend leaned against the body. But the party had no sooner moved off a few yards than the elephant rose with the utmost alacrity and rushed off to the jungle screaming with joy.

Another incident narrated to Sir Emerson Tennent told how two Englishmen endeavoured to stalk a big rogue elephant that was devastating a cocoa nut estate. The brute suddenly rushed out of the jungle at the hunters, who fortunately were enabled in the nick of time to climb a tree. The elephant went straight for the tree. He first stood on his hind legs and made for the hunters with his trunk, but in vain, after which he coiled his trunk round the stem and

pulled at it with all his might, but also without effect. He then applied his head to the tree and tried to butt or push it down, after which he trotted round it several times trying to trample and break down the projecting roots. Failing in all these efforts and seeing close by a pile of timber which had been felled a short time before, he removed these logs carefully, one at a time, to the foot of the tree, tlll he had piled the whole lot, thirty-six logs, after which he deliberately clambered on to the top of them and once more raising himself on his hind legs tried to extend his trunk towards the hunters. This, however, was his last chance, for in doing this he presented a fair mark to their rifles and two shots finished him.

Colonel F. T. Pollok says he has often watched the elephants in a timber yard and the human way in which they will test the weight of a log requires to be seen to be credited. The tusker will lift up one end with his trunk, and, if he deems it within his power to lift the whole, he will shift his trunk gradually until he gets to the exact centre, then by kneeling down he will roll the log on to his tusks and will carry it either to be stacked or to the saw mill.

In tea estates the elephants are occasionally employed to help in building construction by keeping the masons supplied with blocks of stone, and if the wall be not too high they will not only take the block up but lay it quite correctly in its proper place. A Ceylon elephant used regularly to lay stones in this way under the orders of an overseer, to whom he used to signal to inspect and "pass" the work done, and to give permission for fresh courses to be laid. On one occasion the elephant placed himself against part of the wall, thus preventing the overseer from examining that part of the job. The latter, however, insisted on the animal moving aside, and the elephant, seeing his ruse had failed, at once began to pull down the wall which he had just built, and which he was quite aware was badly done, at the very spot where he had tried to conceal it from the eye of his master.

Mr. W. A. Fraser tells some quaint tales which show that the animal has a glimmering idea of what British sport means. Near Meerut an elephant race was got up in which four full-grown beasts were encouraged to negotiate a one mile course which they covered in five minutes. The pace was undeniably slow, compared with what one would see at the 'Varsity sports, but the ponderous beasts did their level best and they all finished close together. In a tug-of-war, elephan *versus* men, one of the former pitted his strength against 35 sailors, but the tars won the day.

The saw mills of Rangoon and Moulmein give daily the best elephant show to be witnessed anywhere. But one day a frightened native came down to the town office of the mill owner, with a typical Baboo's letter reporting "the caprices of a mad, demented elephant, who had already suicided 33 of his defunct relatives, and was now murderously intent on all having a similitude to his kind in the appearance of domestic milch buffaloes, and therefore," the Baboo added, "he is an exuberant bad fellow," pathetically concluding, "My household gods are dislocated because of his illogical discipline." All this sounded sad, and proved to mean that Raja Singh, as the brute was named, had not only picked the manager's dog-cart to pieces, as a boy would dissect a watch, but had demolished a score or so of the coolies' bamboo huts, including even the Baboo's, whose dignity had been thereby hurt. Fortunately the owner had a fighting elephant, who, though a good worker himself, liked nothing better than the occasional relaxation of thrashing a refractory colleague with an iron chain. An assistant executioner's services were secured from an adjoining yard, and the two swooped down upon Raja Singh to administer a little wholesome correction. At first he was highly elate, making sure he had enlisted two recruits to aid him in his fun. But when the heavy chains were brought to play upon his ribs and about his ears he began to think a bit. Then the Phoongye (priest) as the thrasher was called, and his mate varied the dose of punishment by battering Raja Singh backwards and forwards between them till he could scarcely stand, and was easily chained to a stout tree to reflect on the evils of losing his temper.

A few days though sufficed to restore him to his normal senses. When next seen he was pulling great slabs of teak from the tail end of the saw and carrying them off to a distance. A mahout, or driver, was perched on his back, but he had fallen asleep, and the Raja was doing all the work, and the thinking too. He would draw six or eight huge slabs from the pile with his trunk, place them very evenly together, put a chain round them, run it through the slip-hook quite correctly, and attach himself by his traces to the load. Then he would move off majestically, till he came to the pile of slabs, upon which he carefully placed all he had brought, each one in its place where it fitted best, all smooth and even, as a careful workman should.

As the mahout seemed to him to be doing rather less than his share of the job, Raja Singh began to fill his trunk with a few odds and ends on the return journey. A stray nail, three or four pebbles, a tuft of grass with a little earth clinging to the roots, and a discarded cheroot were among the treasures he found, and these, with an upward sinuous movement of his trunk, he suddenly blew against the mahout's naked stomach—one of the little jokes with which he loved to alleviate the hours of labour, just as any other navvy might. After that, who can say that animals are lacking in humour?

A little further off, the Phoongye was piling square timber. Huge beams, a foot square and more, and over 20 feet long, he was carrying on his tusks with ease, and in piling them he was as ingenious as the Raja. He would place one end on the pile, back to the other end of the log, lift it into position, and then take a "squint" along the pile to see that it was all straight. If either end stuck out

too far, he would place his trunk or forehead against it, and shove it in.

At twelve o'clock the whistle blew, and, with the same spirit of punctuality that induces the hod-carrier when half way up the ladder to drop his load of bricks at the striking of the clock, these monsters dropped everything, and turned to the mash-tub full of grain.

It is interesting to observe, however, that instances of sagacity are not confined to the more domesticated animals. A Burmese steam-ship captain, while anchored off the coast, used to see a female elephant and her youngster come down out of the jungle every morning and bathe in the sea. The little chap used to keep in shallow water, while the mother ventured further out; but one morning, while his parent was not looking, the youngster got beyond his depth, became frightened, and made a great to do. The mother pulled him ashore and gave him a good spanking with her trunk. Each succeeding morning the little one was compelled to stand on the bank while the mother first bathed herself, and afterwards washed him down with water fetched in her trunk.

A British officer riding on horseback through a forest, near Kandy, heard some big beast grunting repeatedly in a dissatisfied manner just ahead of him, and at the same time his horse began to show signs of alarm. A little further on he came in sight of a tame elephant carrying a huge beam on its tusks, and in sad trouble owing to the narrowness of the path which compelled him to hold the log in a slanting position, to avoid its catching in the trees on either side. On seeing the officer, the elephant promptly recognised the fact that there was not room for both to pass each other abreast, so the elephant backed sideways into the jungle, leaving space enough for the others to ride on. The horse was, however, too terrified to advance, whereupon the elephant retreated still further into the jungle, but without effect so far as the horse was concerned. On moving for the third time away from the path, the elephant began to show signs of impatience, whereupon the officer dismounted, and leaving the horse free, walked on by himself, and was eventually joined by his steed. The elephant then resumed his march through the wood, and his complaining grunts could be heard for some time after dying away in the distance. Although a simple occurrence, the infusion of something approaching a sense of courtesy invests this incident with a unique interest which, to a lover of animals, is quite touching. C. E. D. B.

DR. SWINEY AND THE SWINEY PRIZE.

Some notes which appeared in the *Journal* of June 23rd, 1899, contained most of the little that is known of Dr. George Swiney. He was educated at the University of Edinburgh, whence he graduated M.D. in 1816 with a thesis *De insania*, and he died at No. 9, Arlington-street, Camden-town, or Grove-street, as it was then called, on January 21st, 1844, in the 50th year of his age. He appears to have been a man of very eccentric habits, living in almost complete seclusion and only leaving his house four or five times a year. His funeral was so peculiar that it was long remembered by the inhabitants of the neighbourhood. In accordance with the instructions of the dead man, the coffin was covered with yellow cloth studded with white nails, and thrown over this was a yellow velvet pall edged with white silk. Immediately behind the coffin came three young girls, dressed in white and wearing violet cloaks, and straw bonnets, trimmed with white satin ribbons. The mourners presented a most singular appearance, resembling more a wedding than a funeral party. So dense was the crowd which gathered around the *cortége*, that a strong force of police was necessary to clear the way; and on its arrival at the cemetery of St. Martin's, Pratt-street, there was a hostile demonstration on the part of the people who surged round the chapel in such numbers that the mourners were unable to get to their coaches, and were compelled to make their way homewards as best they could.

Another proof of Dr. Swiney's eccentricity had already been seen in the manner in which he communicated the terms of his will to the Society. One day, during the secretaryship of Mr. Arthur Aikin, a gentleman entered the office carrying a small parcel, which he requested permission to leave for the Society, at the same time stipulating that it was not to be opened until a letter should be received giving instructions as to its disposal. Years passed, and the mysterious parcel remained sealed. At length a committee was appointed to consider what should be done with it. Finally it was decided to open the parcel, which was found to contain a copy of Dr. Swiney's will. Efforts were then made to ascertain whether Dr. Swiney was still living, but in consequence of the extraordinary seclusion which he affected, all these attempts failed, and finally the matter was allowed to drop until 1844, when a letter was addressed to the Society announcing his death.

Dr. Swiney's name would probably have been forgotten long ago but for two bequests of £5,000 each. The first he left to the trustees of the British Museum for the establishment of a lectureship in Geology, the second to the Society of Arts for the purpose of presenting on every fifth anniversary of his death a silver goblet of the value of one hundred pounds containing gold coin to the same amount, to the author of the best published work on Jurisprudence. The prize was to be adjudged by members of the Society of Arts and the Fellows of the College of Physicians.

The will was proved on February 6th, 1844. In order to obtain a prize of artistic merit and worthy both of the testator and of the Society, the Council offered a prize of £25 for a design emblematical of Justice; but though the offer was kept open

three years and many drawings were submitted, the Committee appointed to consider them were unable to recommend any for the award. In these circumstances the Council commissioned Mr. D. Maclise, R.A., to make a design. This was approved by the Council on March 11th, 1850, and the cup has been executed from it by Messrs. Garrard and Co. ever since.

In 1894 the question of providing a new design was considered, and the Council resolved again to offer a prize of £25 to all students of schools of art in the United Kingdom. A large number of models and drawings were submitted, but the Council, although they awarded consolation prizes to three of the competitors, did not consider any of the new designs an improvement on the old.

According to a contemporary description, "the cup was designed in the French Renaissance style of the eighteenth century, decorated with boldly embossed bulbs, between which is conventional scroll and *fleur de-lis* ornament. The subject of the bas-relief on the body is 'The First Trial by Jury,'* *temp.* Henry II., A.D. 1176. 'By this law the Justices who represented the King's person were to make enquiry by the oaths of twelve Knights, or other lawful men of each hundred together with four men from each township, of all murders, robberies, and thefts.' (*Vide* 'Pictorial History of England.') The figures on the base of the cup represent male and female figures bound together by fetters, and those surmounting the cover symbolize Justice with the scales, on her right hand an Angel pleading for mercy and on her left an officer holding a sword for carrying out the stern sentence of the law. Other attributes distributed about the cover of the cup are manacles, fetters, stones, &c."

* The origin of Trial by Jury is wrapped in mystery, but it is certainly of much more ancient date than that assigned to it here, the only basis for which appears to be the fact that, under an enactment of Henry II. the defendant in certain actions relating to freehold or status was enabled to decline trial by combat and choose trial by assize.

THE DANISH EGG INDUSTRY.

The egg industry in Denmark has been stimulated by the growing demands of the British markets, which in the years 1907 and 1908 consumed annually about 3,800,000 great hundreds of Danish eggs, valued at £1,800,000. Poultry breeding in Denmark is carried on generally on a small scale, and is confined to small farmers, who supply local customers or hotels without any system in placing their goods on the market. It may be said that the fattening of fowls is sacrificed to the production of eggs, and this has determined the breeds of hens used. The original breed of Danish hens, though hardy and good layers, produced small eggs. The American Consul-General at Copenhagen says that to remedy this they have been crossed with other breeds, of which the Plymouth Rocks, Wyandots, Cochins, and Orpingtons are preferred. The eggs are pickled in a solution of lime during the months of April and May, and are offered for sale from October to February. Before and after pickling they are subjected to a critical test by electric light. The sale of eggs in Denmark for home consumption is increasing, and the business is in the hands of traders, who may, or may not, be members of the three associations now making an effort, through experiments, exhibitions, and reports, to ensure progress and co-operation. Of these Associations, by far the most important is the Co-operative Egg Export Association, of Vejle, through which, with a few large export firms, an export business is done which, in 1897, amounted to about £650,000, increasing to £1,370,000 in 1906. As this trade is chiefly with Great Britain it is with a view to the maintenance of good prices that the examination, sorting, packing, and shipping of eggs is carefully carried out. This Association has more than five hundred districts, with a membership of about forty thousand, from whom eggs are collected. Producers must deliver eggs to the district stations, each egg stamped with the member's number. No member is allowed to keep eggs, except for the immediate use of his family. If it is discovered at the sorting and examination at Vejle that kept eggs are delivered subsequently the offender can be traced by the stamps on the eggs. At the first offence he is warned, on the second occasion a fine is imposed, and on the third, he is expelled from the Association. At the district stations the eggs are re-stamped and forwarded to packing stations, of which there are ten in different parts of the country, principally at the ports. Here the eggs are carefully examined by electric light, restamped "D.C.E.A." if good, and forwarded to the packing room, where they are sorted according to size, as this is a matter of importance to the retail trade. They are then packed in cases. All bad eggs are rejected and traced by the stamps back to the seller, who is fined. In this way the Danish association has been able to gain the reputation for handling good stock. This co-operative system has the obvious advantage of dispensing with the expense of dealing through middlemen. It has built up one of the principal businesses of the country, and produced a superior quality of eggs for export.

A NEW PHONOGRAPH.

The methods for recording sound, have reached a higher stage of perfection than those employed for its reproduction. The chief difficulty encountered in the present system of reproducing conversation, and especially music, from phonographic and similar records, is caused by the friction of the needle resting upon a surface of the rapidly revolving disc or cylinder. This introduces a more or less noticeable buzzing or rumbling sound, which interferes materially with the clearness of musical notes or spoken

words. Numerous attempts have been made to overcome this unpleasant accompaniment. In none of the devices hitherto brought forward has complete success been attained, since all involved the factor of friction as the fundamental means of transmission. The American Consul at Chemnitz says that in a recent number of the "Deutsche Musikwerk Industrie," a German inventor describes a newly patented instrument in which friction is completely avoided. It combines the leading elements of the phonograph and the siren. The novel and essential feature is the substitution of a current of compressed air, for the needle or stylus of Edison's invention. In a siren, openings of various sizes allow the production of all musical notes with any desired degree of intensity or length. In the new instrument, perforations in the disc of a siren are replaced by incisions on the surface of a large record cylinder. A second perfectly smooth cylinder rests close upon the surface of the first cylinder, and revolves in unison with it as the two cylinders are set in motion. A constantly varying succession of minute openings between their surfaces is presented, due to the incisions on the record cylinder. When a powerful blast of compressed air is directed upon the line of contact between the two cylinders, at such an angle as to be an exact tangent to the surfaces of both, sounds are evoked identically as in the case of an ordinary siren. It is possible to communicate signals and even words, which can, it is said, be readily heard miles away. It is already evident that a field of usefulness is open to this new invention as an adjunct to the equipment of sea-going vessels. Its availability for musical purposes has not yet been tested sufficiently to determine whether it can successfully vie with the gramophone, phonograph, &c., or even replace them. The cylinders thus far employed are about ten times as large as ordinary phonographic cylinders, and this fact renders the instrument necessarily somewhat clumsy. The requirement of a current of compressed air may also militate against a widespread domestic use, although such a current can be supplied by a comparatively inexpensive attachment to a water tap where the water supply is under considerable pressure.

HOME INDUSTRIES.

Railway Amalgamation.—The Great Northern, Great Central, and Great Eastern Railways Amalgamation Bill has been sent to a Hybrid Committee, which will have power to consider not only this one Bill, but the whole case for and against amalgamation in the public interest. This was the suggestion of the President of the Board of Trade, and induced the House of Commons, by a narrow majority, to read the Bill a second time. The opposition of the traders, who see in it an attempt to deprive them of the guarantees which they have enjoyed under the competitive *régime* without offering them any compensating advantages, or setting up any acceptable alternative policy, has been strenuous and sustained. Hitherto the railways of the kingdom have been worked under a system of what may be called qualified competition—that is, competition subject to Parliamentary objections and statutory maximum rates. Whatever may have been the case in the past, the present position of the railway industry is anything but satisfactory. The cost of railway working has been rapidly rising, both actually and in proportion to the growth in receipts, while the return upon capital has been steadily falling, notwithstanding a very great increase of traffic and of gross earnings. There is dissatisfaction on all sides. Railway shareholders complain that their return is inadequate; traders complain that rates are too high and facilities insufficient; directors complain that they cannot raise capital for even railway purposes—during last year only forty-five miles of new railway were constructed in the whole country; workmen complain that they are under-paid and over-worked. The directors contend that this unsatisfactory state of affairs is largely due to their having to pay excessive prices for land and property; to the undue burden of rates; and to the fulfilment of obligations placed on them by Parliament which greatly diminish their earning capacity. And others would add to these explanations excessive dividends in past times, the charging to capital account of much expenditure which ought to have been met out of revenue, and large expenditure upon competitive services not required and which could not be expected to pay. The question for the House of Commons and the country is whether the remedy for the present discontent is to be sought in amalgamation or in other directions. Amalgamation is no new thing. Ever since railways came into being there have been instances of amalgamation. The early railways were short lengths of line, afterwards amalgamated into great trunk systems. Since then—for the last forty years—the country has possessed a number of powerful railway systems, each to a large extent confined to its own region, but touching one another at various important points, with the result that at the great centres of industry there has been effective competition. The suggestion underlying the present Bill is that it is necessary to do away with competition. But there is the alternative of what may be called free trade in railways. The railways from the outset have been hampered by Board of Trade regulations, many of them needlessly restrictive, and they have been compelled to run trains at non-paying prices for the supposed benefit of working men, a most questionable insistence from many points of view. Again, the railway companies are unfairly burdened by local authorities in the shape of rates. If they were relieved of these burdens, in so far as they are unjust, and left to themselves to do the best they can in competition with one another, subject to some strong central authority empowered to act on its own initiative in defence of the public

interest, it might well be that the present troubles would disappear, or be greatly minimised. In this country we have one great amalgamation at work, namely, that of the South Eastern and Chatham lines, and the result has been extremely disappointing. Instead of mending things have gone from bad to worse, not only from the public, but from the shareholders' point of view. The other illustration within the United Kingdom of the working of amalgamation is to be found in Ireland, where the Great Southern and Western of Ireland effected a similar amalgamation with very similar results.

London Passenger Transport Companies. — It may be claimed for London that it has the best system of passenger transportation in the world, but great as is the benefit to the public of these improved means of migration, those who have found the capital are left lamenting. Suicidal competition has killed profits. With the exception of the Great Northern, Piccadilly, and Brompton system none of the transport companies, as a result of last year's working, could pay anything on the ordinary capital, and in the case of the company mentioned, the distribution was only ½ per cent. *The Times* has published an interesting analysis of the results of working, during 1908, of the various companies which provide travelling facilities for London, including the London United Tramways and the London General Omnibus Company. Roughly, a capital sum of £57,500,000 was employed, of which £25,400,000 was in the form of loan and preference stock, receiving a fair interest, whilst, with the exception of the Central London Railway Company, some £32,100,000 of ordinary and other capital, went unremunerated, or received only a very trifling dividend. The actual profit divisible on this £32,100,000 was only £163,253, and even this was rather abnormal owing to the Franco-British Exhibition, which, it is estimated, gave £50,000 profit to the Central London, £20,000 to the Metropolitan, and £10,000 to the District Company. Deducting this special revenue, the divisible profit on ordinary capital was only equal to a dividend of ¼ per cent., and this in return for moving nearly 578,000,000 passengers.

The Necessitous Mothers Bill.—Encouraged by the success of the Bureau de Bienfaisance, at Ghent, and the School for Mothers, at St. Pancras, and moved by the urgent need for action from the national standpoint, Mr. Robert Harcourt, M.P., has introduced a Bill called the Local Authorities (Necessitous Mothers) Bill, which has for its object the lessening of infantile mortality by properly feeding, instructing, and supervising poor and ignorant mothers. At Liverpool, St. Helen's, Ashton-under-Lyne, and elsewhere, the municipalities facilitate early bottle feeding, by a supply of humanized milk. Mr. Harcourt would feed the mother that she may be able to suckle the child. What may be done in this direction, is indicated by the success of the School for Mothers, in St. Pancras. As late as 1904 that borough was one of the worst in London in respect of its infantile death-rate. Then its Medical Officer of Health, Dr. J. F. J. Sykes, and others, began an educational campaign on behalf of breast feeding. The consequent fall in the infantile death-rate has been very remarkable. It has been brought about by a judicious mixture of feeding and teaching. The Mothers' Welcome not only feeds the mothers, it gives them practical instruction in hygiene, management, and cooking, and in clothing, minding, and management of their infants. Mr. Harcourt's Bill, if it became law, would enable English local authorities to do the same. Entirely permissive, the Public Health Authority would be enabled, if it chose, to provide food, advice, and other assistance to poor mothers from a medically defined point before the birth of their children until six months after their births. It would be able to impose terms on the mothers as conditions of their receiving assistance—for example, that they shall suckle their infants, or attend class, or refrain from going to work, and it would not be allowed to impose more than a penny rate for the purposes of this work. Obviously there are great difficulties in the way of the smooth working of a scheme of this kind, not the least being the dire necessity which so frequently compels a woman to return to work before she is physically fit to do so, and frequently in violation of the Factory Act which forbids a woman to work for a month after her child's birth. It is not likely that Mr. Harcourt's Bill will become law this year or next, but its introduction is a sign of the times, and the growing recognition of the truth that if the physical health of the nation is to be preserved, or restored, greater care must be taken to ensure that the children of the poor, as of other classes, are born into the world healthy, and properly treated and fed in infancy.

The Poisons and Pharmacy Act.—On April 1 this Act, which is the outcome of the recommendations of the Departmental Committee appointed in 1901 to consider whether there was need for alteration in the statutory provisions governing the sale of poisons, came into force. The complaint had been made by farmers and gardeners that owing to the restriction to chemists of the sale of poisonous materials used in agriculture and horticulture, the existing provisions for the distribution of such preparations were insufficient; the Committee endorsed these complaints, and the Act is intended to meet them. It empowers local authorities to grant licenses to nurserymen, florists, seedsmen, and others, to sell sheep dips, weed killers, and insectitides, containing arsenic and nicotine, provided the reasonable requirements of the public with respect to the purchase of such poisonous substances are not already satisfied in the district in question. The license to sell may not exceed 21s., and in the case of renewal 2s. 6d. Whilst relaxing the regulations governing the sale of agri-

cultural and horticultural poisons, the Act seeks to prevent the misuse of other dangerous substances, such as vitriol, nitric acid, and spirits of salts, by making it unlawful to sell them unless the containers are labelled with the name of the substance, the word "Poisons," and the name and address of the sellers. The Act also requires that every shop where the business of a chemist and druggist is carried on shall be under the management of a properly qualified person, whose certificate of registration shall be exhibited in the shop, and the designation of "Pharmacist" is exclusively reserved for persons who are registered under the Pharmacy Act.

The Factory Acts and Australian Competition.—English clothing manufacturers, who have to work under the regulations of the Factory Acts, are complaining that while the shipments to Australia are affected by Commonwealth tariff legislation something like the sweating system is growing in the large Australian towns. And the complaint seems to be well founded. The Queensland Director of Labour, investigating a complaint from Melbourne as to low rates of wages and unfair competition in the Brisbane clothing trade, has reported that home workers are paid 1s. 6d. to 3s. a dozen for finishing trousers, 1s. 9d. to 3s. a dozen for shirts, and 1s. 4d. to 1s. 9d. a dozen for under-flannels.

OBITUARY.

Sir DONALD CURRIE, G.C.M.G.—On the 13th inst. Sir Donald Currie died at the Manor House, Sidmouth, in his 85th year. Born at Greenock he entered the shipping office of a relative in his native town when 14 years of age, and four years later he left for Liverpool to become a clerk in the office of the Cunard Company. He rose rapidly in this service until he was promoted to the managerial staff in 1856; but having long aspired to become a shipowner on his own account, he resigned this post in 1862 and established the Castle Line of sailing ships plying between Liverpool, London, and the East Indies. Ten years later he started the famous Castle Line of steamers sailing between England and South Africa, which in 1900 was amalgamated with the Union Line under the name Union-Castle. As soon as the Cape became the centre of his energies, Mr. Currie, with characteristic thoroughness, set himself to study South African interests, and he soon acquired such a reputation that his assistance was sought in connection with the settlement of the diamond fields dispute and the Orange Free State boundary question, and his services were rewarded in 1877 by the conferment of the honour of C.M.G. In 1881 he was made K.C.M.G. for the assistance which he rendered in transporting troops to South Africa at the time of the Zulu war, and especially in connection with the relief of Ekowe. Sixteen years later, at the Diamond Jubilee, he was raised to the honour of G.C.M.G.

Sir Donald, in spite of the energy which he devoted to his shipping business, found time for many other interests. He sat as M.P. for Perthshire from 1880-1885, and for West Perthshire from 1885-1900. He was a great admirer of Mr. Gladstone, and although on the occasion of the Home Rule split he declared himself a Unionist, he remained on terms of intimate friendship with his former leader. He was also a keen sportsman, delighting until the last year or two in the arduous pleasure of deer-stalking, and his yachting cruises have become almost historical. He had a great taste for pictures, possessing an excellent collection of works by old and modern masters; and his public benefactions were muificent, the most striking being a gift of £100,000 to University College, London, £20,000 to Queen's College, Belfast (in which town he received his own early education) and £25,000 to the University of Edinburgh).

Sir Donald Currie had been a member of the Royal Society of Arts since 1875. He took part in discussions at ordinary meetings on more than one occasion, and in 1880 he was awarded the Fothergill Gold Medal "for the improvements he has introduced into his passenger steamers, having for their object the prevention of loss of life at sea from fire or accident."

QUESTIONS AND ANSWERS.

NOTICES TO CORRESPONDENTS.

On all communications must be written the name and address of the sender, not necessarily for publication, but as a guarantee of good faith.

Each question or reply should be written on a separate sheet of paper, and should bear such signature of the writer, and such address as he wishes to appear.

Questions which can be answered from the usual books of reference, will not be printed.

QUESTIONS.

PAPIN'S DIGESTER.—Can any reader of the *Journal* refer me to a contemporary description of Papin's "Digester?" I have some recollection of having read a very full and interesting account of some experiments made in London by Papin himself with the first apparatus he constructed, but cannot put my hand upon the original description.—X. Y. Z.

VELLUM.—What is the best method of removing stains from the vellum bindings of books?—LIBRARIAN.

JAPANESE WALTZING MICE.—"Medicus" states "Excessive inbreeding of the ordinary species

mice will bring about a similar result." Will he kindly give me his authority for this? Has he tried the experiment himself, or does he know of any case in any work of authority?—ALFRED H. HUTH.

GENERAL NOTES.

THE ROYAL DRAWING SOCIETY.—The twentieth annual exhibition will be held, by permission of the Court of the Fishmongers' Company, in Fishmongers'-hall, Adelaide-place, E.C., from April 16th to 28th.

SPRING MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The semi-annual convention of the American Society of Mechanical Engineers will be held in Washington, D.C., from May 4-7. During the convention there will be professional sessions devoted to steam turbines, the specific volume of saturated steam, stay-bolts, gas-power engineering, oil well pumping, &c. The entertainment features include a reception by the President of the United States, an exhibition drill by troops at Fort Myer, and possibly exhibition flights of a dirigible balloon and an aeroplane.

COMPANIES AS TRUSTEES AND EXECUTORS.—It may be taken as certain that insurance companies and banks will cater more and more for the work of trustees and executors opened to them by recent legislation. The first annual report of the Public Trustee states that during 1908 he became responsible for 425 trusts, and at the close of the year was engaged in administering 325, these representing a capital value of £2,095,000. It is estimated that the capital value of unmatured wills under which the Public Trustee has been informed that he is expected to act, together with the value of the trusts he is now engaged in administering, is in excess of £20,000,000. These figures indicate great possibilities. The system of appointing private trustees has proved in very many instances a failure, and now that other facilities are available its revival is not likely to be of very long duration. But there is no good reason why all, or most, of the business should go to the Public Trustee. For some reasons the public are likely to prefer leading banks and insurance companies willing to do the work. The security is practically as good.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

APRIL 28.—"The Resources of the Peruvian Andes and Amazon." By C. REGINALD ENOCK, F.R.G.S. SIR CLEMENTS ROBERT MARKHAM, K.C.B., D.Sc., F.R.S., will preside.

MAY 5.—"English Furniture Design and Construction." By PERCY A. WELLS.

MAY 12.—"The Principles of Heredity as Applied to the Artificial Production of new forms of Plants and Animals." (Aldred Lecture.) By PROFESSOR ARTHUR DENDY, D.Sc., F.R.S., F.L.S.

MAY 19.—"Railway Development in China." By ARTHUR JOHN BARRY, M.Inst.C.E.

MAY 26.—"The Manufacture of Nitrate of Lime from Atmospheric Nitrogen." By SAM EYDE.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

APRIL 29.—"The Problem of Indian Labour Supply." By SELWYN HOWE FREMANTLE, I.C.S. The RIGHT HON. VISCOUNT MIDLETON, late Secretary of State for India, will preside.

MAY 13.—"Some Phases of Hinduism." By KRISHNA GOBINDA GUPTA (Member of the Council of India).

MAY 27.—"The Function of Schools of Art in India." By CECIL L. BURNS, Principal of the Bombay School of Art. PROFESSOR SIR HUBERT VON HERKOMER, C.V.O., D.C.L., R.A., will preside.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

APRIL 20.—"The Road to South African Union." By the HON. CHARLES GIDEON MURRAY. LORD BRASSEY, G.C.B., D.C.L., LL.D., will preside.

MAY 18.—"Canada as a Field for British Investment." By J. OBED SMITH, Assistant Superintendent of Emigration, Department of the Interior, Canada.

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

F. W. LANCHESTER, "Aerial Flight." Three Lectures.

LECTURE I.—APRIL 26.—*The principles of dynamic support*—The action of an inclined plane—The law of pressure reaction as a function of velocity—The law of pressure as a function of angle—Frictionless flight—The law of power expenditure as based on the laws of the pressure reaction—The laws of pressure reaction and power expenditure quantitatively considered: a discrepancy—The dipping front edge and its lesson—Cyclic motion in its relation to the supporting reaction—Direct evidences of cyclic motion—The quantitative treatment on the hypothesis of a

cyclic component—The power expenditure under real conditions—Skin friction, its nature and magnitude—Skin friction as affecting power expenditure—Skin friction and other factors as limiting the wing area—Aeroplane *versus* pterygoid form—Meaning and influence of *aspect*—Importance of aspect ratio—The gliding angle, as measure of resistance—The minimum gliding angle as a function of the velocity of flight—The coefficient of skin-friction and the aspect ratio as affecting the value of the minimum gliding angle—The angle of inclination as related to the minimum gliding angle—The pressure proper to least resistance—The theory of screw propeller efficiency—Comparison of theoretical results with measurements of birds, flying machines, &c.—Controversy as to influence of skin-friction—Conclusions as affecting the problem of mechanical flight.

LECTURE II.—MAY 3.—*The principles of stability*—The simple glider—The ballasted aeroplane—Form of the flight path as observed—The flight path as plotted from the equation—The phugoid chart and its teaching—Changes of amplitude of the phugoid curve and influences that lead to such changes—Conditions of flight path, stability and the equation of stability—Effects of propulsion on stability—Influence of the flexibility of the aerofoil—Lateral stability—Rotative stability—The stability of birds and of flying machines in practice—Flight path stability desirable but not essential to flight—Steering in altitude and azimuth—Gyroscopic couples—The boomerang—The gyroscope as an aid to stability.

LECTURE III.—MAY 10.—*The Flying Machine.*—The function and uses of the flying machine—Possible types—The conditions to be fulfilled as defining the type—The need for high velocity—The difficulties of high velocity—The horse-power problem—Motors for flying machines and the conditions governing their weight—Fuels available and the relative importance of fuel economy—Propulsion and the propeller—The use of gearing—The limitations of flight as due to the mode of propulsion—Other modes of propulsion—Wing flapping and its efficiency—Soaring—Starting and alighting—Questions of design and construction—Steering and steering mechanism—Flying at a height—The advantages and disadvantages of altitude—Types of flying machine in practice—The future of flight—The flying machine as a mode of locomotion, in peace and war.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 19...British Architects, 9, Conduit-street, W., 8 p.m. Mr. W. E. Riley, "The Architectural Work of the London County Council."

Victoria Institute, 1, Adelphi-terrace, W.C., 4½ p.m. Rev. A. Galton, "Modern Christianity in France, with Reference to the Present Movement."

TUESDAY, APRIL 20...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Colonial Section.) Hon. C. G. Murray, "The Road to South African Union."

Junior Institute of Engineers, Royal United Service Institution, Whitehall, S.W., 7½ p.m. Mr. C. H. Smith, "Systems of Electrical Power Distribution."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. F. W. Mott, "The Brain in Relation to Righthandedness and Speech." (Lecture I.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. C. T. Purdy, "The 'New York Times' Building."

Photographic, 66, Russell-square, W.C., 8 p.m. Mr. Munia Keene, "Racial Types in South Africa, and the Flora of the Country."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 4½ p.m. Miss E. V. Jenkins, "Canada Illustrated by Canadian Artists."

WEDNESDAY, APRIL 21...Meteorological, 25, Great George-street, W., 7½ p.m. 1. Mr. Baldwin Latham, "Percolation, Evaporation, and Condensation." 2. Rev. José Algué (S.J.), "The Meteorological Conditions in the Philippines, 1908."

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Mr. E. Heron-Allen, "The Recent and Fossil Foraminifera of the Shore-sands of Selsea Bill, Sussex." 2. Mr. E. J. Sheppard, "The Disappearance of the Nucleolus in Mitosis."

Auctioneers, 34, Russell-square, W.C., 7½ p.m. Mr. B. I. Breach, "The Practice of Compensation as affecting the Valuer."

THURSDAY, APRIL 22...Royal Institution, Albemarle-street, W., 3 p.m. Mr. J. Paterson, "Aspects of Applied Aesthetics: (1) How a True Art Instinct may be Best Developed."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m.

Historical, Lecture-hall, Field-court, Gray's-inn, W.C., 5 p.m. Miss Leonora de Alberti and Miss A. B. Wallis Chapman, "English Traders and the Inquisitions in the Canaries during the Reign of Queen Elizabeth."

Mining and Metallurgy, Geological Society's Rooms, Burlington-house, W., 8 p.m.

FRIDAY, APRIL 23...Royal Institution, Albemarle-street, W., 9 p.m. Mr. A. Siemens, "Tantalum and its Industrial Applications."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. J. M. S. Culbertson, "The Development of Hydro-Electric Power Schemes: with special reference to Works at Kinlochleven."

North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, 7½ p.m.

Physical, Imperial College of Science, South Kensington, S.W., 5 p.m. 1. Prof W. H. Bragg and Mr. J. L. Glasson, "A want of Symmetry shown by Secondary X-Rays." 2. Mr. C. A. Sadler, "Transformations of X-Rays." 3. Prof. T. R. Lyle, "Theory of the Alternate Current Generator."

African, Trocadero Restaurant, Piccadilly, W., 7½ p.m. Colonel H. E. Rawson, "Some Experiences with Native Tribes in South Africa."

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. Address by the President (Mr. J. A. F. Aspinall).

SATURDAY, APRIL 24...Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. T. Günther, "The Earth Movement of the Italian Coast and their Effects." (Lecture I.)

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FRIDAY, APRIL 23, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, APRIL 26, 8 p.m. (Cantor Lecture.) F. W. LANCHESTER, "Aerial Flight." (Lecture I.)

WEDNESDAY, APRIL 28, 8 p.m. (Ordinary Meeting.) C. REGINALD ENOCK, F.R.G.S., "The Resources of the Peruvian Andes and Amazon."

THURSDAY, APRIL 29, 4.30 p.m. (Indian Section.) SELWYN HOWE FREMANTLE, I.C.S., "The Problem of Indian Labour Supply."

Further particulars of the Society's meetings will be found at the end of this number.

QUESTIONS AND ANSWERS.

In view of the fact that the Royal Society of Arts includes amongst its members authorities on almost every branch of human knowledge, it has been suggested that some space in the *Journal* should be devoted to correspondence of the "Notes and Queries" order. Readers in search of information are, therefore, invited to make their wants known in the hope that they may be assisted by their fellow members. Further particulars will be found under the heading "Questions and Answers, on p. 465.

COLONIAL SECTION.

On Tuesday afternoon, April 20th, the Hon. CHARLES GIDEON MURRAY read a paper on "The Road to South African Union." SIR GODFREY YEATMAN LAGDEN, K.C.M.G., presided.

The paper and discussion will be published in the next number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

Tuesday afternoon, April 6th; the Right Hon. SIR WEST RIDGEWAY, G.C.B., G.C.M.G., K.C.S.I., in the chair.

The CHAIRMAN, in introducing the reader of the paper, said that no one interested in Ceylon could fail to know that the name of Ferguson, in the person of the author and of his uncle, both of whom had been decorated by their Sovereign, was intimately associated with the prospects and progress of the island. For nearly half a century Mr. Ferguson had laboured in the cause of Ceylon, indeed it had been a labour of love with him. As editor of the principal papers of the island, and of the "Ceylon Directory," which was a mine in which every Governor delved and sought for information and enlightenment; as a lecturer in the United Kingdom and the United States of America; as a member of the British Association, in every branch of which he took great interest, so far as it could be made to serve the interests of Ceylon; and as a member of the Legislative Council, the author possessed eminent qualifications for writing a paper on the industries and material progress of the island.

The paper read was—

CEYLON: ITS INDUSTRIES AND MATERIAL PROGRESS.

By JOHN FERGUSON, C.M.G.

Wellnigh ten years have elapsed since I had the privilege of reading a paper before this Society on "Old and New Colombo," with Sir Thomas Sutherland, G.C.M.G., of the P. and O. Company, in the chair: an occasion which, as the late Sir Charles Kennedy declared at the time, constituted a successful inauguration of the Colonial Section of the Royal Society of Arts. I have now been asked to supplement that paper with some account of the industries and recent material progress of Ceylon, and I am honoured by having for Chairman one of the ablest and most successful of the Governors of this colony in modern times.

Introduction.

By way of introduction, I should mention that the island has an area of 25,000 square miles, a little less than Ireland, with a population slightly exceeding 4,000,000, of whom the major portion are Sinhalese, supplemented by Tamils, Arab descendants, Malays, Burghers, and Eurasians, while the colonist or European community does not number more than 6,500, including men, women, and children. The principal towns are Colombo, the commercial and political capital, with some 185,000 people; Kandy, the whilom capital of the Kandyan kingdom, with 30,000; Point-de-Galle, once the great mail steamer port, but now comparatively insignificant in trade, with 40,000 people; Trincomalee, with the finest natural harbour in the island or in the East, but with no trade, little cultivation, and only 12,500 of population; Jaffna in the north, a great centre of Tamil agricultural industry, with 48,000 people; Batticaloa, another specially Tamil centre, with 11,000 people; and Newera Eliya, the sanatorium, 5,500. Then there are several minor but interesting provincial capitals and towns apart from what are known as the ancient "buried cities" of Anuradhapura and Polonaruwa, long the seats of native government, large population, and extensive industry; but now chiefly remarkable for the ruins of palaces and temples; and made readily accessible of recent years by railway communication, and by motor-cars travelling over good roads.

History.

Before turning to the text of my discourse, I may just mention that authentic history and settled government in the case of Ceylon may be said to date from about 500 B.C., and that native rule, under kings of diverse and often opposing races, and marked by frequent wars and much disturbance, lasted for wellnigh 2,000 years, before Europeans, in the persons of the Portuguese, first appeared, and gradually took possession (not without much opposition) of the coast districts, west, south, east and north. These they held for 150 years, but though the attempt was frequently made, they never were able to conquer the Kandyan Kingdom, the strongholds in the hill country being comparatively inaccessible through the absence of roads. About the middle of the seventeenth century the Dutch ousted the Portuguese, and in their turn held the maritime provinces for 150 years, until relieved by the British in 1796, who finally took possession of the whole island, not by right of conquest, but through amicable negotiations with the Kandyan Chiefs, who practically dethroned their last king, a monster of cruelty, and handed him a prisoner to the English Governor while arranging for the transfer of their country to the British Crown on certain specified conditions. Ceylon has, therefore, been administered as a British colony, the maritime provinces for 112 and the whole island for 93 years.

Description.

In attempting any general description of the island, I always think of the opening sentence in Sir Emerson Tennent's monumental work which runs as follows:—"Ceylon, from whatever direction it may be approached, unfolds a scene of loveliness and grandeur unsurpassed, if it be rivalled by any land in the universe." From the coconut palms bending over the sandy shores until they almost kiss "the league-long rollers" of the Indian Ocean, up to the top of its highest mountains, Ceylon is one vast continuous botanic garden, full of plants, flowers, ferns, and orchids, only known to the possessors of extensive conservatories in temperate regions. But my task to-day is not to tell of what is interesting to the botanist, zoologist, or lover of natural history generally; to the sportsman, historian or archæologist; but rather to describe briefly the principal industries and the material progress of recent years.

Rice-growing and Irrigation.

Ceylon is pre-eminently dependent on agriculture, and the cultivation of rice, the staple food of the people, was naturally one of their earliest occupations which in time—with the fostering of irrigation and construction of immense tanks, lakes and inland seas under autocratic as well as enlightened native monarchs—developed a great industry sufficient to maintain a considerable population. This was chiefly on the north-central plains, where now, as the result of prolonged continuous wars between the Sinhalese and Tamils, the country is almost entirely covered with jungle and most thinly populated—one or two persons to the square mile. For the past 400 years, at least, Ceylon has been more or less dependent on India for a proportion of its food supply, and, notwithstanding much attention given and much money spent by the British Government in fostering and restoring irrigation works, since the develop-

ment of the planting enterprise in coffee, tea, &c., during the past 70 years by Europeans, and the great increase in trade and in urban population, this dependence on India for rice supplies has been greatly emphasized.

During the past 50 years special attention has been given by successive British governors, beginning with Sir Henry Ward, to the encouragement of rice-growing by the natives, and, altogether, not less than a million and a quarter pounds sterling from revenue and loans have been devoted to irrigation, the largest outlay having been during the administration of Sir West Ridgeway. Much benefit has undoubtedly resulted not only in affording means of industry and subsistence to a rural population in remote districts, but in greatly improving the sanitation and the health of the people through providing a good water supply, the clearing of low jungle, and the inducement of regular cultivation. But at the same time it must be confessed, little or no progress has been made towards rendering Ceylon independent of India or Burma for its rice supply. For whereas 40 years ago the total annual importation of rice was 4,406,216 bushels, the equivalent, it was estimated, of less than half the consumption of the island, now (for 1907)* the import has risen to 10,697,254 bushels, and is equal to quite three-fifths of the total consumption. Be it remembered, however, that in the meantime the population has nearly doubled, and that the total cultivation on plantations has quadrupled in the same time.

CINNAMON.

The next oldest cultivation to rice must be that of cinnamon, which is undoubtedly indigenous to the island, and which, as grown in Ceylon, affords the finest spice of its kind in the world. The trade was first developed by Arab voyagers (the "Moormen" of Ceylon history). In the time of the Emperor Augustus Ceylon cinnamon was sold in the streets of Rome at the equivalent of £5 sterling per pound. Now the very best is to be got in Mincing-lane for 2s. 6d. per pound. The Portuguese and Dutch chiefly valued Ceylon for its cinnamon, the latter also getting a good deal of pepper from the vine which grew freely in the Kegalla and Matara districts. It is evident that the cinnamon shrub has been cultivated on the same light siliceous soil on the west coast of Ceylon (chiefly in the Negombo district) for over 2,000 years. The crops and exports have increased greatly within the past 20 to 30 years, but the profit is limited, since production is apt to outstrip the demand. Much of our Ceylon cinnamon goes to Spain for the flavouring of chocolate, and to the South of Europe generally for incense in the churches. The cultivation and preparation of the bark is purely a native industry.

* For 1908, the importation was below the average because of the scarcity and dearness of rice in India: but the current year shows a much increased import so far.

PALMS: COCONUTS, &C.

But far more important to the natives (and to many colonists) is our great industry in palm cultivation: coconuts chiefly, nearly all round the island, though mainly from Matara up the west coast to Puttalam, and all over the Negombo, Chilaw, and most of the Kurunegala districts—but also the palmyra palm in the north of the island; arecas in Kegalla and western districts; and kitul (*Caryota urens*) and the grand talipot (*Corypha umbraculifera*), peculiar to Ceylon, in the western interior. The coconut probably floated to Ceylon from its habitat in the Eastern Archipelago* before the Christian era, and its spread along the coast, at the instance of successive native rulers, is related in the "Mahawanso." But until 100 years ago coconuts were used solely to provide food, and light, through their oil, for the natives. The first cargo of coconut oil shipped from Ceylon to Europe was in 1818; but no special impetus was given to the trade till about fifty years ago, when a great deal of planting took place, and mills on a large scale for expressing the oil were established in Colombo. Now, coconuts—through the manufacture of oil, of coir (the fibre), of desiccated coconut (for confectionery, &c.), and the shipment of copra (the dried kernel), of punac (the crushed cake for stock feeding) and of the nuts themselves—form one of the largest of Ceylon industries, and provide work (as well as a great deal of their food) for a large number of the people, the Sinhalese more particularly. The palmyra (*Borassus flabelliformis*)† also gives oil as well as sugar to the Tamils of Jaffna; the areca palm supplies the much-used betel-nut to the native, and a great deal is exported to India; and the kitul‡ or jaggery palm, also yields sugar, sago, and toddy wine to the Kandyan.

* See paper on the "Coconut Palm in Ceylon: Beginning of its Cultivation," by J. Ferguson, "Journal of the Royal Asiatic Society," Ceylon Branch, No. 57 of 1906.

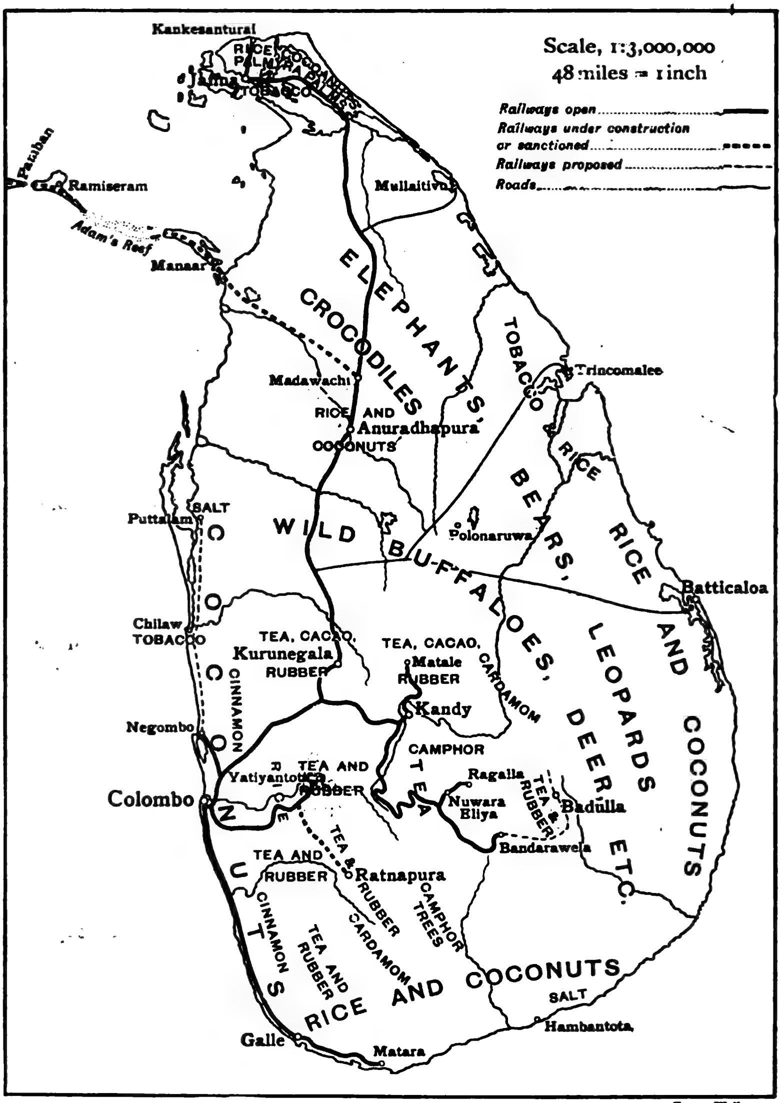
† Suited for a dry region, while the coconut requires more rainfall, as a rule.

‡ Emerson Tennent mentions a single kitul palm which was the main support of a Kandyan, his wife, and children.

Minor Products.

Pepper, tobacco, and cotton are minor but gradually growing industries among the natives, the cultivation of which, the Government, by experimental gardens and instruction, is endeavouring to extend. In growing and cinnamon leaf, timber, and fibres of various kinds also afford minor industries to the natives.

It must be mentioned that the coconut palm, which is supposed to flourish best on the seacoast, is successfully grown far in the interior,



Emery Walker sc.

Map of Ceylon.

vegetables and fruit of many kinds there is a considerable industry; but there is scope for much more, and some day there may be an export trade in canned pineapples and mangoes, and in banana flour, as now there is in desiccated coconut. Essential oils from citronella grass in the Matale, Kandy, Dumbera, Badulla, and other valleys, and also around towns in the drier districts, such as Anapapura. Indeed, Dr. Willis shows (see "Tropical Agriculturist" for January, 1909) that with irrigation this palm may be profitably cultivated right over

the North-Central, Northern, and Eastern districts wherever tanks are restored or are in working order. Only occasional watering is required. So also with cotton and tobacco cultivation, in which the Government experimental stations lead the way.

Stock-raising.

Another proposal made to utilise land in the North - Central Province has been for cattle stations, and a retired Ceylon proprietor (with experience of stock-breeding in England), after watching the cattle sent from Anaradhapura to the Kandy and Colombo markets, declared that if he were a young man he would readily invest capital in stock, provided the Government gave land on easy terms for a cattle and perhaps a sheep station. The encouragement is found in the fact that at present Ceylon imports cattle, sheep, goats, and poultry from India, and pays as much as £100,000 a year in this way, besides cold storage imports from Australia and Europe. The total number of live stock held by the natives of Ceylon is about 2 millions in cattle, goats, &c.*

Coffee: its Rise and Fall; and Modern Science in Tropical Agriculture.

Whatever may have been the case in the North-Central division 1,200 to 1,700 years ago, there can be no doubt that with its peculiarities of soil, rainfall, and climate, Ceylon (at least the South-Western portion) in the present day is far better suited to grow crops of leaf (tea), of various palm nuts (coco, palmyra, areca), of bark and spices (cinnamon, cardamoms, pepper, &c.), and now of the latex or milk of rubber trees, than it is for crops of cereals, whether of rice, maize, or dry grain. Accordingly, the modern progress and prosperity of Ceylon is usually dated from 1837, the year in which coffee-planting on its hillsides began to attract general notice; and, with many vicissitudes, ups and downs, this industry grew for 40 years until it reached a maximum annual crop of 1,000,000 cwt., worth between four and five millions sterling, grown on some 200,000 acres. Then came its downfall, due to an insidious fungus, which first appeared on the leaves of coffee in 1869, gradually weakening and practically killing the bushes, so that by 1890, the export had fallen to 90,000 cwt., while now it is about 1,000 cwt., grown on a few hundred acres. In 10 years Ceylon lost some 500 of its planters while the industry was practically ruined.* To shew the great progress of scientific agriculture within the past 30 years, the United States Agricultural Department and the Dutch at Buitenzorg, Java, leading the way (with Peradeniya, Ceylon, not far behind), I need only mention that Mr. Wilson, the then and present Minister of Agriculture at Washington (a Scotchman born), told me, in 1904, that he felt certain his staff could overcome the coffee, as they had baffled the orange, fungus, if they had encountered it in the "seventies;" while Dr. Treub in Java showed me last September a coffee plant† which had been improved and developed until

* Ceylon is, by nature, provided with a breed of cattle much better suited to its climate and roads than any that can be imported. Its small, compact, hardy, black cattle—now becoming extinct—are not only good for food, but they are the best for draft purposes, and should be preserved for the conveyance of rice and coffee to and from the interior. Now, although sheep do not thrive on the herbage of the southern provinces, and the leeches of the Kandyan country—except be above the elevation suited for the culture of coffee—prevent their being reared with success in the central province, no country has sheep better adapted to its climate than the Jaffna sheep are to the northern province; nor is the mutton of a well-fed Jaffna wether surpassed by that of any imported sheep. Jaffna sheep not being provided with wool to enable them to withstand the cold at Nuwera-Ellia, it may be desirable to import some with sufficient natural covering to keep them warm at such high elevation. But for no other purpose would it be necessary to import either cattle or sheep if the natives were properly instructed by English graziers in the improved method of breeding, rearing, and preparing the natural breeds of the island—the horned cattle for draft and the Jaffna sheep for the table. The money that has been fruitlessly expended on the importations of sheep from Aden, Bengal, Coimbatore, the Cape, and England, would have paid for a skilful English grazier's visit to Ceylon for the purpose of instructing the Ceylonese in his art.—*From Notes by James Steuart in* 1855 *after* 38 *years' residence in Ceylon.*

* How coffee utterly failed, to the ruin and disappearance of many of our planters, while many more bravely held to their posts, first planting cinchona, and then tea and cacao and cardamoms, and more recently India-rubber trees, camphor, and pepper, is a matter of modern history in Ceylon, and one full of romance as well as of illustrations of indomitable pluck and perseverance. Nothing ever recorded in the annals of agricultural or planting industry elsewhere in the world affords quite a parallel. For, as Sir A. Conan Doyle writes in one of his works: "Not often is it that men have the heart, when their one great industry is withered, to rear up in a few years another as rich to take its place, and the tea fields of Ceylon are as true a monument to courage as is the lion at Waterloo. My story concerns the royal days of coffee-planting in Ceylon before a pestiferous fungus drove a whole community through years of despair to one of the greatest commercial victories which pluck and ingenuity ever won." Let me say that the five million pounds sterling worth of coffee in the maximum year in the seventies, is now represented by tea, cacao, cardamoms, and rubber to a value of not less than £5,500,000—tea alone making up for the coffee—and with rubber this will soon exceed £6,000,000.—Ferguson's "Ceylon Illustrated." [Sir A. Conan Doyle on being referred to lately, writes:—"I remember the passage quite well; but can't say where it came from."]

† *Coffea robusta.*

it has proved to be immune so far as *Hemileia vastatrix* was concerned. Similar success has attended the work on cacao, tea, and palms of our Scientific Staff at Peradeniya, (first started on a liberal scale by Sir West Ridgeway), and so we no longer fear the diseases or enemies of our tropical products, whether tea, cacao, rubber, or palms; for the scientists have successfully overcome several of these already.

Cinchona: its Rise and Fall.

To go back to the dark days of "coffee," the brave men who stuck to their posts with *nil desperandum* as their motto, in the eighties, first tried cinchona plants to supplement or supplant their old staple, and these succeeded so well that in a few years the annual exports of the bark reached (in 1886) nearly 15,000,000 lbs., and so the price of quinine (which had been a guinea, and was for long 16s. an ounce) came tumbling down until it reached 1s. 6d. a lb.; and then the narrow margin would not pay the Ceylon planter for harvesting and shipping the bark, and the cinchona industry had to be abandoned in favour of Java, where a much richer (volcanic) soil and scientific guidance as to seed selection, enabled a far larger percentage of the alkaloid to be obtained from the bark and a cinchona growing industry to be continuously maintained, until Java now practically supplies nearly all the world's requirements.

Tea: its Permanent Success.

Most fortunately for the Ceylon planter, before his cinchona collapsed experiments in tea cultivation and preparation demonstrated a new and profitable product far better adapted to the climatic conditions and soil than ever coffee was or possibly could be.* The latter was an annual fruit crop (of berries), the failure of which meant a whole year's labour gone; while successive leaf crops from tea can safely be counted on for at least nine months of the year, the picking of the plant by the coolie women and children going on at intervals of eight to ten or twelve days. With wonderful rapidity did the planting of tea extend until the 10,000 acres planted by 1880 had increased to 220,000 by 1890, and now, in 1909, we have between 390,000 and 400,000 acres; but some 60,000 of these are interspersed with rubber trees, which, as the more valuable product, will gradually supersede the tea.

Cacao, Cardamoms, &c.

Many were the experiments made in different districts by different planters with other products besides tea when coffee and cinchona failed; for instance, with kola nuts, coca erythroxylon, West African palm nuts, pepper, &c. But the only products that made an appreciable mark were *Theobroma cacao* (the cocoa or chocolate of the breakfast table) and cardamoms, the spice so much used in their curries, &c., by the natives of India, and latterly growing in favour in Europe, Australia, and America. Cacao requires a comparatively rich soil and a low or moderate elevation, and has, therefore, to be confined to certain limited areas; whereas tea—one of the hardiest of plants—grows from seaside level to plantations at quite 7,000 feet altitude. Cacao after some years became affected by a fungus that threatened its extinction; but it was taken in hand by the plant Pathologist at Peradeniya, and under scientific direction the Ceylon planter has quite overcome this enemy, as he also keeps in check several minor troubles that from time to time affect his tea. There is no branch of agriculture all the world over without its drawbacks; the primal law applies more or less to all: "in the sweat of thy face shalt thou eat bread." Beginning with 300 acres in 1878, cacao now covers some 29,000 acres in certain suitable districts, chiefly around and north of Kandy. The spice, cardamoms, is also confined to a few districts, chiefly, however, because the world's demand is at present a limited one, not encouraging extended cultivation. The progress in planting has been from 1,200 acres in 1880 to 8,500 acres at the present time.

* It is pleasant to find a medical authority writing in favour of tea and coffee. In a recent volume, "Health and Common Sense," Dr. Woods Hutchinson says of tea and coffee:—"Few discoveries of the wit of man have," we are told, 'added more to the comfort and happiness of life and less to its miseries than tea and coffee.' They are a splendid 'introduction committee,' and are only injurious when there is an excess of tannin present. Most of the 'tea-poisoning' symptoms of the poor seamstress or working women are signs of starvation, not due to the tea which she can get, but to the lack of food which she can't afford. If you take either late at night they'll be likely to keep you awake; that's what they were introduced for originally—one by the bonzes of Thibet and the other by the monks of Arabia. The 'dyspepsia' attributed to them is due nine times out of ten to the food taken with them. No disease known to the medical profession is directly attributable to them."—*Home and Colonial Mail*, 1909. [This reminds me that linen-workers in the North o Ireland, working long hours, find good tea and potatoes the cheapest and most sustaining food; while French colliers also, with many hours' work daily, lived chiefly on coffee and potatoes.—J. F.]

THE STORY OF RUBBER-GROWING—A GREAT INDUSTRY.

The story of the latest addition to the planting industries of Ceylon — namely in rubber-yielding trees, particularly Para rubber —has recently been related by more than one lecturer, but especially by Mr. Herbert Wright, the author of the latest standard Manual for the rubber planter,* before the Royal Society of Arts. Suffice it for me to say that in 1876 the first plants of *Hevea* or Para rubber reached Ceylon from Kew (Mr. H. A. Wickham having brought them from Brazil) and were planted at Heneratgoda.† These parent trees are now 34 years old and are still flourishing. For some time considerable interest was taken by many Ceylon planters in rubber, but chiefly in the Ceara species, which disappointed expectations, and tea then proving a great success, rubber altogether got neglected save by a few fortunate individuals, who planted Para rubber, chiefly in the Kalutara district. At the instance of the late Dr. Trimen, of the Botanic Gardens, I compiled and published a "Manual for Rubber Planters" first in 1883; the second edition appeared in 1887, and the third in 1899. But comparatively few copies of these were utilised in Ceylon, most of them going to the Straits and Malay States, where, in consequence of the failure of Liberian coffee, more general attention was given to Para rubber than in the case of Ceylon; and although of late years our planting has approximated to that of the Malay States, still there is a far larger proportion of mature trees in the latter than in our island. That is shown by the much larger export up to date from the Malay States. But it is quite possible that after some years the exports from the two countries may begin to approximate more closely; for the area planted with rubber in Ceylon (180,000 acres) was, until lately, in excess of that planted in the Malay States. At the same time, it is quite a question whether the conditions of climate are not, on the whole, more favourable in the Malay Peninsula. On the other hand, we may be quite sure that the utmost justice will be done in liberal as well as judicious cultivation, harvesting and preparation of this valuable product in the first of Crown Colonies, whose planters have so long acquired the reputation of leading the world in everything connected with tropical agriculture. Only eleven years ago (1898), the area planted with rubber-yielding trees in Ceylon was but 750 acres; but three years after, this was increased to 2,500, and by the middle of 1904 to 11,000 acres. Since then the progress has been very rapid. By the middle of 1905, the returns showed close on 40,000, and a year later over 103,000 acres; while in August, 1907, this was increased to 146,000; and on 31st July last (1908), the figures returned by the planters for the Directory worked out to 180,000 acres. At the same time good authorities consider that a certain limited percentage of this area, injudiciously planted, is not likely to come to maturity; but further planting has gone on since, and is still going on, so that 180,000 to 200,000 acres may safely represent the industry as at present in Ceylon. Last year the export was 407½ tons, against 1,413 tons from Malay States, and about 221 tons from Sumatra, Johore, &c. (worth together probably £900,000); while it is estimated that in 1912, Ceylon may give 3,000 tons (worth at 3s. 6d. per lb., say £1,170,000), the Malay States, 7,500 tons (worth £2,925,000), and all Southern Asia perhaps 12,000 to 13,000 tons (£5,070,000).* I submit these figures,

* "Para Rubber," 3rd edition by Herbert Wright; published at *Observer* office, Colombo, and at 37, Shoe-lane, E.C.

† INTRODUCTION OF HEVEA TO THE EAST.—It has always been generally understood that the first introduction of *Hevea brasiliensis*, the Para rubber tree, to the East was in 1876, when a consignment of rubber plants came to the Peradeniya Botanical Gardens authorities in Wardian cases, the plants being those raised at Kew from the seeds brought over from Brazil by Mr. H. A. Wickham. This, however, is not really the case, for the first *Heveas* were sent to the East 3 years previously in 1873. Our authority for this is Colonel Prain, Director of the Kew Botanic Gardens, who, in response to a letter on the subject, writes:—"Regarding the introduction of *Hevea brasiliensis* to the East, I take pleasure in enclosing a copy of a memorandum prepared from the entries in the inwards and outwards books which will explain exactly how this matter stands. You will see that although the first distribution to the East took place in 1873, and that the distribution of 1876 which was rendered possible owing to the energy of Mr. Wickham was not the first, yet to all intents and purposes the 1876 distribution is to be considered the first." The memoranda sent by Colonel Prain are as follows: "Kew Inwards book, 1873, p. 54:—'From India Office, obtained by Markham from Jas. Collins. Seeds of Hevea, India-rubber tree. Several hundred, about a dozen germinated.' This entry is in Sir Joseph Hooker's writing. The note on the germination of the seeds is in Sir W. T. Thiselton-Dyer's writing. Outwards book 1873, p. 267:—'Six plants were taken out on Sept. 22nd in a Wardian case by Dr. King for Calcutta.'"—*Ceylon Observer*, March, 1909.—[But Dr. Sir George King made little or nothing of the 6 plants he got in [illegible] —*J. F.*]

* By the *Ceylon Observer* of March 15th, I see that Mr. Carruthers, Director of Agriculture Malay States, has stated that 60,000 acres were planted there with rubber last year, and that the total planted now is 240,000 acres,

with some diffidence, as it is very difficult to know what additions Sumatra, Java, North Borneo, as well as Southern India and Burma, may make to the exports of the two chief planting countries, and also whether the price (now 5s.) will keep as high as 3s. 6d. per lb., three years hence. Be it noted, however, that the Ceylon and Malay States planters are prepared to face much lower prices; for their product can be turned out for 1s. a lb—indeed, Company reports have shown a cost so low as 9½d. In a financial paper a few days ago, it was wrongly stated that plantation rubber could not be grown at less than 1s. 6d. per lb., whereas wild rubber, costing 1s. 8d., could be supplied for less if the necessity arose. This remains to be seen; for another authority declares it costs 2s. 6d. a lb. to bring Amazonian rubber to port of shipment. The scare about "synthetic rubber" seems to have subsided, and most people accept the view of a high chemical authority that a commercial rubber is not likely to be produced in the laboratory to compete in quality or price with natural rubber. You may judge from the figures I have given, how immensely important the rubber-growing industry in all Southern Asia, covering perhaps 520,000 acres, now is, and what its value will be when all the trees are ready for tapping five or six years hence. At a moderate computation, a crop of some 36,000 tons seems then (say in 1914) to be very likely, and even at about half the present average in London, per lb., or say 2s. 6d., this means a value of £10,000,000 sterling in a single year. The share of this appertaining to Ceylon should not be less than £3,000,000 sterling, five years hence. Here is surely a reason for the Colonial Office sanctioning all the railway and road extensions pressing for attention at this time.*

37,000,000 rubber trees, or an average of 154 per acre. If so, Ceylon has been outstripped; for I scarcely think the total of planted rubber in the latter can exceed 210,000 acres at the middle of this year. But these increases should not affect the calculation as to the position in 1912. For the first quarter of this year, the exports of rubber from Malaya nd Ceylon are much in excess of the same period last ar. Mr. Carruthers also mentions that the Malay States ave now 112,000 acres planted with coconuts.

Since the Paper was read I have had the benefit of Mr. Carruthers' perusal of it, and apart from some minor corrections embodied in the text, he tells me that he considers the soil for rubber trees better in Ceylon than in Malaya, but that the climate of the latter is much more favourable for rapid growth. As regards exports, Mr. Carruthers' official return of crop for 1908 for Malay States was 1,580 tons (including Johore), and for 1912, he estimates as much as 16,000 tons—not counting Straits Settlements, Johore, Kelankan and Keda. At this rate, all Southern Asia should give 20,000 to 22,000 tons in 1912!

Camphor Trees.

Camphor is a minor product started in the higher districts of late years, and there may be trees planted now to an equivalent of 1,000 acres in the case of Ceylon.

Total Cultivation and Areas in Ceylon.

Finally, here is my estimate as compiled for "Ferguson's Ceylon Handbook and Directory" for 1908-9† of the total cultivation in the island and probable extensions:—

	Acres cultivated.		Probable eventual extension. acres.
Rice (paddy) cultivation....	610,000	..	800,000
Other grain (Kurakkan, Indian corn, pulses, and legumes)	120,000	..	250,000
Coconuts (European and Native)	750,000	..	1,000,000
Arecanuts, Palmyra, and Kitul palms	140,000	..	250,000

* A Remarkable Dividend.—An interesting annual report—that of the Korossa Rubber Co., Limited—has just reached us from Ceylon. This company possesses twenty acres only in bearing and 26 acres of young rubber. The issued capital is £6,000, and the company pays, from the profits made since the inception of the company, 21 per cent. dividend in its second year. Surely this is a record, and should provide food for thought for investors who have doubts as to the potentialities of the industry. We know of no parallel case where twenty acres in bearing have paid such a handsome dividend on the whole of the issued capital. It is quite clear that if the mature area was capitalised at actual cost there would have been a dividend considerably higher than 100 per cent.—*India Rubber Journal*, April 5th, 1909. [I may add to the above a case that came under my notice when visiting the Malay States in September last; an individual planter in the Perak district, holding 100 acres planted with rubber trees which were all in bearing in 1907, netted an income for that year of £3,500.—J. F.]

At one time the world's record for the highest value in agricultural land was held by the celebrated vineyards in the Cantenac, Margaux, and other communities of the Bordeaux district. These values, seldom over one hundred and twenty pounds per acre, had gone long before the advent of rubber plantations; but at their best they would have paled before the three hundred pounds per acre, at which rate fairly mature rubber works out in the prices actually paid for shares in some of the Malayan companies. It is possible to frame almost any estimate of profit from a rubber plantation if the returns actually given by single trees or small plots be taken to represent actual figures. Single trees have given in a few months twelve to twenty pounds of rubber, worth over five shillings per pound, and small areas have given returns equal to more than sixty pounds sterling per acre profit in the year. The planter knows, however, that when he has to deal with more closely planted trees, and has to take the average for some years of large areas, the figures will be different, although still in his slumbers dreams born of avarice are more likely than nightmares of poverty!—Thomas North Christie in *Chambers' Journal* for August, 1907.

† Published in Colombo and at 37, Shoe-lane, E.C.

Cinnamon	45,000 ..	55,000
Cardamoms (European and Native)	9,000 ..	12,000
Other spices, nutmeg, clove, pepper, vanilla, ginger, &c.	10,000 ..	50,000
Other palms and fruit-bearing trees and shrubs, jak, breadfruit, plantains, pines, oranges, mangoes, &c. ..	250,000 ..	400,000
Garden vegetables, roots, yams, cassava, manioc, potatoes, cabbages, onions, chillies, cucumbers, &c...	120,000 ..	250,000
Tea (European and Native too)	392,000 ..	429,000
Rubber trees	180,000 ..	250,000
Chocolate plant (cacao) (European and Native) ..	35,000 ..	45,000
Cinchona	173 ..	150
Camphor	1,200 ..	10,000
Sugarcane	20,000 ..	40,000
Cotton	2,000 ..	25,000
Tobacco	25,000 ..	50,000
Citronella grass and other essential oil grasses	40,000 ..	60,000
Rhea, aloes, and other fibres	1,000 ..	50,000
Coffee (both kinds), European and Native	2,000 ..	3,000
Other new products	5,000 ..	50,000
Blue gums and introduced timber trees	10,000 ..	30,000
Cultivated grass land	15,000 ..	30,000
Patana, natural pasturage, &c.	1,000,000 ..	1,000,000
Total acres..	4,087,333	5,130,150

The estimated total extent of the colony (including lakes, lagoons, backwaters, &c.) is 15,809,280 acres. It will thus be seen that at present only about 4 millions out of the 15 of which the island is composed are cultivated, or utilised for pasture.

Staple Exports from Ceylon since 1880.

I may now sum up the export of the island's staple products for a number of years:—

	Tea.	Cacao.	Rubber.	Cardamoms.	Cinchona.	Coffee.	Cinnamon.	Coconut oil, copra and punac.	Coir, rope, yarn, and fibre.	Desiccated coconut.	Plumbago.
	lbs.	cwt.	tons.	lbs.	lbs.	cwt.	lbs.	cwt.	cwt.	lbs.	cwt.
1880	162,575	121	nil.	16,069	4,161,989	656,595	1,609,548	446,246	67,763	nil.	205,738
1890	45,799,519	15,981	½ ton.	387,940	8,779,140	90,091	2,345,564	529,916	123,959	nil.	392,577
1900	149,264,602	33,476	4 tons.	537,455	510,462	10,773	4,541,517	992,418	215,077	13,604,913	383,350
1905	172,629,966	69,463	68	874,625	234,499	7,723	5.303,676	1,258,833	285,451	20,779,236	627,910
1906	169,909 335	54,[illegible]	130	732,136	297,613	7,472	5,893,306	1,249,329	288,564	20,213,570	703,666
1907	182,023,732	92,511	245½	789,495	234,449	1,849	6,194,384	1,091,351	312,472	23,303,497	640,521
1908	180,049,321	62,186	407¾*	715,418	180,689	1,072	6,019,053	1,743,558	305,641	27,410,230	525,095

There is also an increasing export of coconuts in the husk, as many as 21,188,692 of nuts in 1908; and of citronella oil distilled from the grass, 1,390,602 lb., and 290,878 ounces of cinnamon oil, and of pepper 1,224 cwt. last year.

The figures for 1908 are according to the Report of the Ceylon Chamber of Commerce, published at the end of February last.

* This is Ceylon produce; and besides, 134½ tons from India and Malay States, were re-exported from Colombo.

Gems.

Having in my paper on Colombo dealt fully with the native industry in gem-digging for rubies, sapphires, topazes, amethysts, catseyes, &c., which goes back to time immemorial, I will pass it over now with the remark that there are perhaps 20,000 of the natives, more or less, engaged in the very speculative work of digging pits, and washing streams for gems. Their return on the average is a poor one, probably not equal to labourers' wages; but there is the gamble, and occasionally gems worth £2,000 and even £3,000 each have been found. Cut-glass imitations from Birmingham and the Continent of Europe are freely offered in Colombo, Galle, &c., and visitors have to beware, although they cannot but be interested and perhaps agree with Miss Jewsbury, who wrote:—

> And when engirdled figures crave,
> Heed to thy bosom's glittering store—
> I see Aladdin in his cave;
> I follow Sinbad on the shore.

Pearls.

Then there is the pearl fishery on the banks off the north-west coast for which Ceylon has so long been celebrated, and which, to the advantage of the Government and people of Ceylon, was leased for a term to a London company, four years ago, with stipulations as regards experiments in culture of the pearl

oyster, which are now in process of being carried out and are full of interest. When there is a successful fishery, and still more a series of prosperous fisheries, employment is given to a large number of natives, as boatmen, divers, and workers ashore, most of the divers coming from India and the Persian Gulf, while hundreds of native dealers with thousands of attendants come from all parts of India and the East to buy the oysters or pearls.

Plumbago.

Of far greater importance to the island and people than gems or pearls is the industry in the provinces in digging or mining plumbago—our one mineral of special commercial importance—and the preparation and packing of the same in Colombo by some thousands of women chiefly, for the great firms making crucibles in London, New York, and Germany. Ceylon plumbago is nearly all devoted to crucibles, and in a time of war, with guns, &c., to make, the demand is keen. During the South African war the price doubled from £30 to £40 to £60 and £80 a ton, and as 25,000 to 30,000 tons are shipped in a year, many of the native mineowners were greatly enriched. Only one English company is engaged in plumbago mining; some of the native mines go down 350 feet and have steam-engines for the pumps, and Government has now an expert Inspector of Mines. Among other minerals found in Ceylon thorianite has recently attracted attention, and 12 cwt. were exported last year.

Elephant-catching and Art-work Industries.

Of other native industries, mention may be made of the capture of elephants to sell to the rajas and maharajas of India, of which sometimes 100 are exported in one year. Then come Kandyan art work industries, revived and maintained under official auspices, in brass, as well as silver and gold, lacquer work, in highly-coloured mats, in baskets, in pottery, &c. In the low country also numbers of the villagers weave and plait, and "Kaltura baskets" are very popular with visitors as well as in England; and, of course, there is the considerable industry in Colombo, Jaffna, Kandy, Matara, Negombo, &c., in manufacture of jewellery, cutting of gems, tortoiseshell work, ivory, horn, &c.*

Lace.

I must not omit to mention the lace industry, which employs many Sinhalese women. The lace is pillow lace, but as the industry is entirely unorganised, only the easiest kinds, such as Torchon, are made, and that is often very poor, especially as the women can only afford to buy inferior thread. Efforts are now being made to improve the quality and design, and when this is done there should be a ready market in the countries farther East, in the Australasian colonies, and America.

Fisheries.

The Fisheries round the coast give employment to many of the Sinhalese, and much might be done to add to the food supply by stocking tanks, lakes, and rivers, as well as in conserving the game of the country. Societies formed by the colonists for both purposes are in operation, and trout have been introduced into some of the mountain streams and Newara Eliya lake with success.

Forestry.

Forestry, more especially in the conservation and thinning of existing Government forests, is an important work in Ceylon, and under its present practical head, the Department has begun for the first time to supply sleepers to the railway, cheaper and of more lasting quality than have been hitherto imported. This is apart from considerable sales of timber for building, cabinet work, &c. Ceylon used to be famous for its fine cabinet woods in calamander, tamarind, satinwood, ebony, &c., and for the carving of the last-mentioned; but there is a scarcity now, calamander trees, for instance, being nearly all extinct, but the Department is arranging for nurseries and plantations. There is a certain limited export of forest produce in dyes, drugs, &c., duly recorded in the Customs accounts.

Increase of Population.

One of the best evidences of material progress and extended prosperity in Ceylon during the period of British administration is found in the increase of its population. Estimated at less than a million in 1815, when the whole island first came under our rule, it is now over four millions. A good deal of this is owing to the immigration and settlement of Tamil coolies in the island. These must now number quite 700,000, chiefly in the planting districts, though many are in the towns. But the Sinhalese have also greatly multiplied, espe-

* Any one interested in Sinhalese Arts and Crafts should refer to Dr. Comarasamy's elaborate and profusely as well as highly illustrated "Monograph on Mediæval Sinhalese Arts and Crafts," published a few months ago. Apply to the author, Broad Campden, Gloucestershire.

cially of late years, and have doubled in numbers since 1863.

Revenue, Trade and Roads.

The development of the general revenue which is now close on 2½ million pounds sterling a year, or double what it was so recently as 1893, is another prosperous indication. But still more important is the increase in the total value of the island's trade, which now approximates to from 18 to 20 millions sterling per annum, or three times what it was after the coffee failure twenty years ago, and considerably more than twice the amount it reached in the height of coffee prosperity thirty-two years back. Roads and bridges are the most potent means of developing a young colony, and in the first thirty years of the planting enterprise much was done, as well as continuously since, so that Ceylon has now about 3,000 miles of metalled and 1,000 of gravelled roads—among the best in the world—while, when the British first arrived, there was nothing worthy of the name of "road" in the island. Nevertheless, to meet the requirements of planting, especially of the new rubber industry, and of native agricultural progress in palms and rice, new roads and bridges are required and should be steadily supplied.

Railways made and Constructing.

In 1867, the first railway from Colombo to Kandy was opened, and if Governor Sir Henry Ward had had his way, this line would have been finished many years earlier, to the great advantage of agricultural industry, as well as of the island's trade and revenue. Then followed a succession of periods of agitation on the part of the colonists to get indispensable extensions sanctioned by the Colonial Office, which has far too much delayed railway progress, so that the important Dimbula-Uva line cost ten years of battling with Downing-street, to get passed. At length, in 1896, we got a strong Governor—a worthy successor of Sir Henry Ward—who carried the boldest programme of railway additions ever undertaken during one rule. This included what is known as our "Great Northern Railway," 198 miles long, opening up the North-Central and Northern districts, and connecting the densely populated Jaffna peninsula with Colombo and the rest of the island. Sir West Ridgeway also got for us the Kelani Valley narrow-gauge line of 47½ miles, serving populous native districts and one of the most prosperous planting divisions, and another 2½-feet light line of 19 miles, to serve the Sanatorium and rich planting divisions beyond. Altogether, at the end of his term of government in 1903, Ceylon had some 562 miles of railway at a cost of £5,000,000 sterling, most of which has been paid for out of general revenue, chiefly from railway profits—all the lines being owned by Government and yielding returns to the Exchequer far in excess of any of the Indian or other colonial railways. This is our justification for urging that there should be no cessation in railway construction until every revenue station in the island is connected and served. During his short term of office, Sir Henry Blake secured a small branch line, now about to be opened, from Ragama to Negombo, 14 miles, and to the same Governor also belongs the credit of an extension line of 26 miles now under construction to Ratnapura, the capital of the province of Sabaragamua and the centre not only of native mining, gemming, and agricultural industries, but of a great tea and rubber-planting enterprise.

The Manaar and Indo-Ceylon Railway.

To our present Governor (Sir Henry MacCallum) belongs the credit of securing the sanction for the important light broad gauge extension from the Great Northern line to Manaar, some 60 miles, also advocated by his predecessor. This is an important link in the Indo-Ceylon railway which is bound to be fully realised before many years go by.* The South of India Railway is extending on the metre gauge to the end of the island Rameswaram, leaving a gap of 21 miles across "Adam's Bridge" coral reef, which has been surveyed and estimated by two independent engineers (one of whom, Mr. F. J. Waring, C.M.G., has done so much for Ceylon railways). This gap, the engineers reported, can be compassed by a viaduct on screw piles or crossed by a solid roadway between two masonry walls built on the coral, for the sum of 25 million rupees, about £1,600,000 sterling—probably for less when the railway is finished on each side. Meantime, until this reef is occupied, a steam launch ferry, worked

* The project of an Indo-Ceylon railway was brought before the London Chamber of Commerce in a Paper by Mr. J. Ferguson in March, 1897, and this Paper, revised and extended, was again read before the Imperial Institute early in 1898, when a full discussion took place.

on either side of "Adam's coral bridge," according to the monsoon, can be utilised. This line will at once become the great coolie route between India and Ceylon, and also for many Europeans and well-to-do Indians, Colombo, with its magnificent harbour, becoming more and more the passenger port for Southern India, while the sanitarium of Newera Eliya, greatly improved by Sir West Ridgeway and Sir Henry MacCallum, will draw more and more visitors from all parts of India, as well as from Burma, the Straits, Australia, and Europe. Already "Cook" is arranging for through railway tickets between Calcutta (or Bombay and Madras) and Colombo.

Two Railway Extensions Urgently Required: to Chilaw-Puttalam and to Badulla and Passera.

Recurring to the subject of island railways, the urgent necessity at present is for the sanction of two more extensions to serve important towns and districts having an assured profitable traffic. First, there is the line which has been pressingly urged by the new Ceylonese body, the Low-country Products Association of Ceylon, and which would run through what is without exception the richest and one of the most populous native districts in the island, namely, from Negombo to Maravilla and Chilaw, through a continuous series of villages surrounded by rich coconut and cinnamon gardens; and thence on to Puttalam, another centre of coconut cultivation and the great source of our salt supply—a Government monopoly—ensuring a traffic of 10,000 tons of salt for distribution all over the island. This light broad gauge and cheap railway of about 54 miles is assured of traffic which, it is estimated, will yield 10 per cent. on the capital outlay, whereas the Government only require 4½ per cent. for interest, and sinking fund; and yet the Secretary of State recently proposed that a sum of two million rupees of the colony's money should be invested as a reserve outside the island, to yield 2½ or 3 per cent. interest, as a guarantee against future misfortune; and this at a time when, apart from the prosperous tea, cacao, and palm (coconut) industries, quite two to three million pounds sterling have been invested by colonists and their friends in the rich and most promising young rubber planting industry, from which the return in income, trade, and revenue is only just beginning to come in. In the planting (including palm) industry, there is a guarantee of the very best kind for Lord Crewe and his advisers, and if the two million of rupees are invested in carrying on the Negombo Railway to Chilaw (to be continued to Puttalam) they will get not 3 but 8 to 10 per cent. return on the cost, and satisfy a most loyal and industrious native population, who are extremely eager to have this railway. For the Sinhalese (Buddhists as most of them are, and, therefore, opposed to animal traffic) are the most liberal patrons of railway travelling of any population in the world, taking their means into consideration. The Legislative Council, the Planters' Association, and the Chamber of Commerce of Ceylon, as well as the Native Low-country Association have unanimously protested against this absolutely unnecessary and short-sighted locking-up of two millions of rupees, and it is to be hoped the Colonial Office will withdraw its reserve proposal and sanction an investment in the Chilaw-Puttalam Railway instead. All local railway authorities are agreed that it will be a great economy if the engineering staff and labour force construct, without interruption, the line from Negombo to Puttalam. Another most desirable and urgent section of extension is from Bandarawalla to Badulla (the capital of the province of Uva) and Passera, both centres of most important tea, cacao, and rubber cultivation, with much of native industries. This is a more difficult line from an engineering point of view; but it is certain to be profitable, and its urgency is shown by the prevalence of rinderpest among the cart bullocks in this distant province at the present time. Relief by motor-car services is projected, but such cannot be permanently satisfactory, for every year has shown increasingly the force of Sir Guilford Molesworth's declaration many years ago that for the Ceylon hill country, where the plantations mostly are, nothing can give permanent satisfaction between a good road and a good railway. Moreover, extensions to Badulla-Passera and from Negombo to Puttalam (about 100 miles in all) would meet the urgent needs of the colony for some time, and even when paid for, the total outstanding public debt of Ceylon would not exceed the equivalent of three years of the general revenue, while there would then be 760 miles of Government railway, ensuring the rapid development of agricultural industries besides yielding an ample direct return to the general revenue.

Colombo Harbour Works: Largest Artificial Harbour in the World: American Fleet Easily Taken in.

Moreover, as representing part of the Public debt and indicating material progress of a most important kind, I now come to the grand series of harbour works at Colombo,* giving us the finest and largest artificial harbour in the tropics—I may say in the British Empire; for it is only a few acres behind the National Harbour at Dover in size. There is an area of 660 acres, with a low water depth of 30 to 37 feet on much of the area, enclosed within its series of three breakwaters (1½ mile in length in all) and the harbour is supplemented by a first-class Graving Dock and Patent Slip—all due to the genius of the late Sir John Coode and his successor, Sir William Matthews, K.C.M.G.†

Thirty Thousand Passengers Annually Pass Through Colombo.

No small part of the prosperity of the Colony is due to these harbour works, which have constituted its capital (Colombo) the fourth or fifth greatest port for tonnage in the world, and which, apart from ensuring moderate regular freight for the island's produce, yield a profit to the revenue after providing interest and sinking fund on the portion of their cost raised by loan. It is estimated that 30,000 passengers (apart from natives) pass through Colombo—the marine Clapham Junction of the East—every year, and they, of course, spend much money ashore to the benefit of the Government railways, native servants, cab-owners, rickshaws, shops, hotels, &c.

Sanitation of Colombo.

And this brings me to a great work, pressing on the present Governor of Ceylon and his advisers, in the scientific drainage and sanitation of Colombo, the former being in the hands of Mr. Mansergh, of Westminster, and the latter involving great changes in Colombo Lake, which, however, I trust, will not interfere with its beauty and the amenities of its surroundings: the "blue lake of Colombo" (as Miss Martineau once put it), "whether gleaming in the sunrise or darkening in the storms of the monsoon, never loses its charm. The mountain range in the distance is an object for the eye to rest lovingly upon, whether clearly outlined against the glowing sky or dressed in soft clouds, from which Adam's Peak alone stands aloft, like a dark island in the waters above the firmament."

Other Works: Marconi System.

Sir Henry MacCallum is also duplicating part of the railway lines leading out of Colombo, a work necessitated by the great increase of passenger (native) as well as goods traffic, and he has interested himself in several other important improvements—not the least being a great telephone extension and the introduction of the Marconi system of wireless telegraphy between Minicoy and Colombo—all well calculated to promote the material progress of the colony. In other respects, it is to be hoped the Governor and his advisers, with the sanction of Lord Crewe, will do their best for the welfare of the people entrusted to their care, as well as for the liberalising of the Legislature and the Administration. But I must not enter on this to-day or go beyond the scope of my present paper, which has to do

* The foundation stone of the first breakwater was laid by H.M. The King, when as H.R.H. Prince of Wales he visited the island in December, 1875. The total cost of three breakwaters, protecting arm, graving dock, reclamations and accessories will approximate to £2,750,000 (a protecting breakwater, now under construction, will be finished before the middle of 1912). The Admiralty pays a portion (£160,000) of the Graving Dock, the first sod of which was cut by Governor Sir West Ridgeway in March, 1899. The total of the Harbour revenue now approximates to £150,000 a year and is steadily increasing year by year. Between 600,000 and 700,000 tons of coal are landed in Colombo every year, for the coaling of steamers almost entirely. There are nearly 700 licensed cargo boats in Colombo harbour. The tonnage of shipping (apart from coasting vessels) arriving at Colombo is between 7 and 8 millions, and Ceylon produce gives more than 400,000 shipping tons of freight to Europe each year.

† On the visit of the American Fleet to Colombo last December the Master Attendant of the Port was able to allot berths to all inside the harbour without interfering with the ordinary trade of the port. On the 13th December 15 large American battleships were securely berthed in the harbour in 4½ hours, and on Thursday, 17th, at noon, there were in the Harbour 41 vessels, all ocean-going steamers, including the American Fleet of 16 battleships and 4 auxiliaries. On the 20th the fleet left the harbour, consisting of 16 battleships and 2 auxiliaries, in 1 hour 13 minutes. In addition to the foregoing, which showed remarkable smartness on the part of Captain Legge and his staff, and also spoke well for the capacity of the harbour, the American despatch vessel attached to the fleet was docked, cleaned, painted and undocked in the graving dock in 24 hours, and, in fact, was the first American vessel to use the dock. The American ships are very much of the same design and capacity as H.M.'s ships, and considering that, in addition to the accommodation of the fleet and the collier auxiliaries in connection therewith, the ordinary business of the port was carried on at same time, this demonstrates that Colombo Harbour possesses great capabilities. The two main breakwaters—the south-west and north-west—are exposed to a very heavy wave stroke coming dead on from the Indian Ocean.

only with the industries and material improvement of Ceylon.*

Colonists: Brother and Sister for the Tropics.

I may mention that large as is our planting community in Ceylon—some 1,800 managers and assistants for some 1,700 regular plantations—when the rubber area now planted begins to yield widely, say by 1912, there ought to be room for additional young men to supervise the harvesting and preparation of the latex; and I may be pardoned for airing here a hobby of mine, ventilated from time to time, for many years back, when I happen to be lecturing in the United Kingdom, and on which I recently wrote in the *Spectator*, and that is that where there are daughters in a family, with a son going to the tropics (or even to any colony) a sister should accompany, or be prepared to join each brother. In the case of young men going out to be trained as planters (or as junior mercantile assistants) it would be prudent to wait till a charge was obtained or a bungalow established; but in the case of members (even cadets) of the Public Service, the salary allowed—in India especially at once, and after language examinations in the tropical colonies—is ample for setting up house, and the presence of a lady would really be an economy. I have known very many cases where valuable young lives would, humanly speaking, have been saved (over and over again, in India, and even in Ceylon) had sister accompanied brother. Then in the process of time, of course, the natural result would be an exchange of sisters (as the responsibility of married life could be faced) with this great advantage, that experience of climate and housekeeping, &c., would have been gained; while if there was failure of health through a tropical climate not suiting, it would be so much easier for a sister (than for a wife) to return home.*

Climate.

As regards climate and health in Ceylon, I can only say that during the past four months in England, I have thought more about the weather, and taken greater precautions in regard to climate, than I have done in over forty years in Ceylon—and this reminds me again of the saying of a former Chief Justice of the island, Sir Edward Creasy, in a note to his "History of England," namely, that he saw more distress (from cold, no doubt, as well as poverty) during a winter's morning walk from his lodgings in London, than during his thirteen years' residence in Ceylon.

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* If it were within the scope of my paper, I could have here referred to the wide spread of education in the island (and the great advance of Christianity, through Missions), Ceylon being ten times in advance of India in proportion to population. But a very great deal remains to be done, more especially in female education (and in India, too, where only half a million girls are in the schools against 5,000,000 boys). As more in keeping with a paper dealing with material prosperity, mention may be made of the multiplication of substantial public offices, and especially of hospitals and schools, throughout the island: of many fine public, mercantile, and residential buildings in Colombo, including the finest hotels in the East, with good hotels also in Kandy, Newera Eliya, and other towns; and as an evidence of prosperity and enterprise, I would point to the several first-class engineering, iron, and building firms established in Colombo, and up country, ready to contract for factories and machinery for the planter, merchant, or native capitalist, or to build for Government, or private parties, to any design. It is keenly felt in the colony, that the Ceylon Government and Downing street, with the Crown Agents, do not, in this respect, give due encouragement to private enterprise, or take proper advantage of the public spirit and competition of merchants and contractors to relieve official agencies, which cannot do certain work, or supply certain materials, so economically, *pro bono publico*.

* In this connection I cannot resist quoting from a letter kindly sent me by Dr. Parkin, C.M.G., to whom I wrote on reading in one of his public addresses how much he favoured such emigration as I have indicated :—

"26th March, 1909.—I thank you sincerely for your letter of the 24th instant. and the cuttings which you enclose. With all that you say, and with all that is mentioned in the different articles, I fully agree. A few years ago, I had to make a serious study of conditions in the North West of Canada for *The Times* in a series of articles which were afterwards published, in a small book called 'The Great Dominion,' by Macmillan. The result of my studies convinced me, and I mentioned the point particularly in one of my letters, that young men were continually going to pieces when sent out alone under influences of loneliness and temptations to drink [also in the case of India and the tropics, temptation to overwork in studying for examinations, as well as in public duties, and to be careless about changing wet clothes, &c., —J. F.] and that their sisters could do no greater good than by accompanying them, and giving the country also the advantage of the influence of good English women. What was true of Canada is, as you say, still more true of tropical climates. I had much talk with the new Bishop of Zanzibar last spring on this question, when we went together to address the boys at Eton. He was full of the subject. I am quite aware that the conditions of life in such countries are in some ways harder for women to bear than for men, but hosts of women have come through it successfully, and while such countries take a heavy toll of our young men, I do not see why this toll should be made heavier through the fear of women to face the same difficulties and dangers. Both are greatly lessened when they are faced by men and women together. If I get some other opportunity, I shall try to emphasise this matter more in public. As a matter of fact, however, work of such various kinds presses upon one that it is almost impossible to find time for helping forward such ideas as this in the way that one would like to. Be sure, however, that you have my complete sympathy, and what you say will stimulate me to seize any occasion that offers for spreading the ideas."

[After the reading of the paper, some sixty slides were shown on the screen, illustrating the various towns, ancient capitals, railways—completed, constructing, and projected—the industries and products of Ceylon.]

DISCUSSION.

Mr. F. J. WARING, M.Inst.C.E., C.M.G., after showing a series of lantern views illustrating railway construction in Ceylon, said the author had given some most valuable statistics with regard to the staple exports of the island. Taking the figures for 1908 and presuming that a coconut weighed 1 lb., which was much below the mark, 1½ to 1¾ lbs. being, he thought, nearer the average, the weight of the coconut products shipped from Ceylon amounted to nearly 125,000 tons, and the net weight of the tea, not counting the packing, to 80,400 tons, most astounding figures. The author had stated that "Adam's Bridge" was largely a coral reef. As an engineer, he (Mr. Waring) wished it was. He made a complete survey of Adam's Bridge, in 1895, taking soundings between each island, in addition to making many borings to a depth of twenty-five to thirty feet, and he found nothing but sand. Adam's Bridge was about twenty-one miles across, and about half the distance was either sand-banks, or water less than three feet deep. The wider the channels between the sand-banks, as a rule, the shallower they were, but in some places where the channels were narrow, he found, by sounding, that the depth was as much as 30 feet in one case. It was a curious thing that, whether the channel was shallow or deep, a sand-bank was invariably thrown up like a bar at its mouth, so that no boats, except the smallest canoes, could pass through. On referring to a chart which was made by Lieutenants Powell and Ethersey, of the Indian Navy, between 1838 and 1845, he found that the changes in the sand-banks and the channels were so great, that the map he (Mr. Waring) made of the channels and the islands differed entirely from it, so that it might be taken for granted that the whole of Adam's Bridge consisted merely of shifting sand-banks.

Sir ARUNDEL T. ARUNDEL, K.C.S.I., said the author had referred to the ancient invasion of Ceylon. It was well known that there was an invasion by the hero and demi god, King Rama, to recover his wife, and that he went by way of Adam's Bridge, which it was said was made of monkeys, *i.e.*, the aboriginal tribes, who probably provided him with boats. He desired to ask Mr. Ferguson whether there were any legends in Ceylon which indicated that such an invasion took place, and whether the object at which they aimed was the chief city of Anuradapura. That such an invasion would have taken place for so insufficient a reason as the recovery of the wife of the demi-god Rama might be considered extremely unlikely; but it must be remembered that there was another story of a similar nature told by Homer with regard to Helen, who was abducted, and as the result the city of Troy was besieged for ten years. It might be asserted that it was romancing in both cases, and that Homer was pulling our then uncreated legs. With regard to Adam's Bridge, when he was in charge of the railway portfolio in India he visited, at the end of 1904, the island of Rameswaram. The railway was then completed as far as the last projecting point in India, but had not crossed over to the island of Rameswaram. There was then a scheme for making a port which was to be known as Port Ampthill; that the railway should be continued to the extreme end of Rameswaram; and that it should then be constructed over Adam's Bridge. In the map of Ceylon shown by the author he noticed that the projected railway up to Adam's Bridge was marked by a dotted line as a scheme. The railway had now been completed from the Indian side to the extreme end of the island of Rameswaram. As the present channel is extremely tortuous and large ships cannot go through it, it was proposed that a channel should be cut clean through the island of Rameswaram, which, as far as could be judged, was composed of sand. The suggested new channel would be about three-quarters of a mile long, and as broad as might be necessary. The question then arose whether there was proper protection for the shipping in Port Ampthill. It so happened that he met Captain Sinclair, who was in charge of the Marine Survey, and that gentleman pointed out to him that on the south side there was very little difficulty in providing for large ships, only a small portion of rock or sand having to be cleared away for the purpose. But in the end, the scheme for the construction of Port Ampthill was abandoned for the present, owing to the nature of the channel through Palk's Straight into the Bay of Bengal, which would have to be buoyed throughout. Whether that great scheme would ever be carried out in the future he did not know. The author had incidentally referred to Colonial Office obstruction. He (the speaker) did not know whether officials in Ceylon had had to complain of the action of the Home Government with regard to purchasing the stores for the harbour, &c. For instance, were they obliged to send an indent in August for a pump that they required some time in the next year? That was the sort of experience Indian officials had had, and the delays thereby caused were very serious. At one time it would have been impossible for anybody, from the Viceroy downwards, unless it was a case of extreme urgency, to order even a typewriter in Calcutta: the official had to indent for it the August of the year before he wanted it. That state of affairs had, he hoped, been considerably modified by the new rules. The author had referred to his particular hobby that brothers who went out to Ceylon should take their sisters with

them for company, marriage very often resulting with somebody else's brother. He remembered a gentleman who lived a very solitary life in India for a very long time, who finally decided to enter upon matrimony. He had been for so long in the country that he had lost touch with most of his friends in England, but he knew one family with two sisters, Mary and Elizabeth. He, therefore, addressed a letter in the most honourable way to the parents, and applied for the hand of Miss Mary, but in his postscript he said, "If Miss Mary is engaged, Miss Elizabeth will do."

Mr. G. B. LEECHMAN referred to the fascination that Ceylon exercises over all residents and visitors. Mr. Ferguson had mentioned that many believed it was the Ophir of King Solomon; others contended that it was the scene of some of the adventures of Sinbad the Sailor. One of the chief features of Sinbad's island was the Loadstone Mountain, which attracted any ship made with iron nails, &c., that came within its reach, so that it was inevitably wrecked. It was an interesting fact that the native boats in Ceylon, the catamarans, the outriggers, &c., were made entirely of wood, being lashed together with string made from the husk of the coconut. The people of the country, whether Tamil or Sinhalese, were most interesting.

Mr. JAMES PIERIS (of Colombo) said there was no one more capable of dealing with the statistics of Ceylon and the general condition of the country than Mr. Ferguson, whose residence of forty-seven years in the island had enabled him to accumulate a store of knowledge which had been of infinite use to others. He had not kept that knowledge to himself, but had freely given it not only to the people of Ceylon but to those of other countries who felt an interest in the colony, and in that way he had advanced its interests to a great degree. He (Mr. Pieris) wished to express the thanks of the people of Ceylon to Mr. Ferguson for the very good work he had done in the Legislative Council as member for the general European community. He had not represented the European community alone, but had looked after the interests of all communities.

The CHAIRMAN, in proposing a vote of thanks to the author, said all would agree that Mr. Ferguson was not only a master of his subject, but a lover of it. Indeed, as had been remarked by another speaker, that was peculiar to everybody who had been in Ceylon. No one who had lived there could help loving the island, and looking back to it with the most kindly memories. The paper had recalled to his mind very many pleasant memories, and touched several sympathetic chords. Most of those present were aware that Ceylon was a very beautiful country, with a perennial summer, situated in a region beyond cyclones and earthquakes, with a happy and contented population, a thriving revenue, and two splendid harbours in Colombo and Trincomalee, the latter, unfortunately, deserted for the moment. He desired to remind the audience of a fact which was often forgotten in connection with the Crown Colonies, namely, that in them were to be found those great harbours, which had been constructed, and were now maintained at the expense of the Crown Colonies, without which the Navy would be useless and British commerce paralysed in time of war. The disaster which befell the coffee industry, and the magnificent efforts which were made by the Ceylon planters, in the face of that disaster, were well-known. Instead of lying stricken on the ground, they rose and girded themselves, and from the ashes of that disaster there rose the still more splendid industry of tea. If any had supposed that a similar disaster might possibly befall the tea industry, the author must have convinced them that there was no such danger. In the first place, the tea plant was a very much more hardy one, and since the days of the coffee disaster science had advanced with great strides. There was now at Peradeniya a scientific staff, whose business it was to look after all the products of the island. As soon as there was any appearance of disease or pest the fact was signalled to Peradeniya, the danger cone was hoisted, instructions were issued and faithfully obeyed by the planters, and inevitably the pest was extirpated. Then, probably, a good many were not prepared to hear how little Ceylon was dependent upon tea. Many people had the idea that Ceylon had all its eggs in one basket, so that if anything happened to the tea industry the island would be ruined. That idea was really behind the hesitation of the Colonial Office to give Ceylon what it wanted in the way of railways. It was now known, from what the author had stated, that Ceylon had many industries and many products. The coconut industry, for instance, was approaching within measurable distance of tea, while the new rubber industry was exceedingly promising. He claimed for himself some credit with regard to the latter, because when he was Governor of Ceylon the rubber industry was in its infancy and somewhat ridiculed, but he added to the staff of the Peradeniya Gardens, and one of the gentlemen appointed happened to be Mr. Herbert Wright, who had been referred to in the paper. The experimental cultivation which was then undertaken supplied the seed which had enabled rubber cultivation to spread to a great extent in Ceylon. He entirely agreed with what the author had said with regard to railway construction. Railways had made Ceylon. They had made traffic, and that was the truth which had to be inculcated into those in authority at the Colonial Office. He specially wished to see the connection constructed between India and Ceylon. That was one of the ideas he had in his mind when he urged the construction of the Great Northern Railway. He had been somewhat disappointed to find that the lands which it traversed had not been opened up and occupied as he

had desired. When the railway was being constructed large irrigation works were simultaneously made, and it was his hope that when the railway was finished and the irrigation works completed, as they now were, the redundant population of the Jaffna Peninsula and South India would pour into the lands of potential fertility. Some experiments in cotton cultivation were begun, but he had not heard what the end of them was. He still hoped that the work might be entered upon, so that inducements might be offered to emigrants, and the country be able to provide itself with the rice it now had to import. Nobody admired the Colonial Office administration more than he did; justice was not done to it. It was extraordinary how the department administered the colonies in their various stages of civilisation, and with so many different races and peoples, and how sympathetically it governed. There were colonies governed absolutely by the man on the spot, and arising gradually to the stage of self-governing colonies with all the glory of practical independence. Each colony had to be treated separately, and that was where the Colonial Office had shown so much tact and wisdom. But he thought they made one mistake in trying to do everything for themselves in the Crown Colonies. Private enterprise ought to be more encouraged, and permission given for railways, now constructed out of revenue, to be made by private companies, as had been the case in India. He hoped the Colonial Office would be induced to reconsider their decision with regard to locking up Rs. 2,000,000 outside the island against possible disaster. What good would Rs. 2,000,000 do? It was a mediæval financial policy; it was the system of finance which was known and very popular with their grandmothers in their dotage, and he hoped the author and his friends would do their best to induce the Colonial Office to abandon so unenlightened a policy.

Sir Thomas H. Holdich, K.C.M.G., K.C.I.E., C.B., in seconding the motion, said his personal thanks were due to the author for having recalled to his mind so many delightful recollections of a too short official visit to Ceylon. It had also been of great interest to him to hear of the developments of the country during the last fifteen years, in all of which, whether the extension of the railways, the initiation of a scheme for restoring old irrigation works, the conservation of forests, or the promotion of the growth of rubber, he could trace the hand of the Chairman.

The resolution was carried unanimously.

Mr. Ferguson, in reply, expressed his grateful thanks to the audience for their kind vote of thanks. Among the many omissions from the reading of his paper, perhaps the most important was the reference to the Manaar Railway, which their present "Engineer-Governor" of Ceylon had carried as a consequence of the Great Northern line being made by Sir West Ridgeway. That railway was to be constructed to the furthest point of Ceylon, and the South of India Railway Company were constructing it on the other side through the island of Ramiseram, so that only the twenty-one miles of viaduct over Adam's Bridge remained to be built. But before that viaduct was made, they hoped to have a steam-launch ferry on each side of the reef or sand-banks. He was very glad to receive Mr. Waring's correction with regard to Adam's Bridge, but there was an Anglo-Indian engineer who took a rather different view. In any case, when the viaduct came to be constructed everyone would learn what Adam's Bridge was actually made of. Sir Arundel Arundel's and Mr. Leechman's references to the old tales with regard to King Rama, &c., brought up interesting traditions; in fact, Ceylon was full of tales of romance and much of historical interest. The Seeta-ella stream in the hill regions witnessed to the capture and rescue of Queen Seeta from the Ceylon king of the demons. In conclusion, he wished to express, not only on his own behalf, but he felt sure on behalf of all the audience, their most cordial thanks to the Chairman for his great kindness in coming to preside over the meeting.

HOME INDUSTRIES.

The Wheat Industry.—The rise in the price of wheat is a matter of great national importance, apart from the seriousness of the loaf at 7d. to the mass of the community. It is of this importance because there are grounds for the belief that whilst the price of wheat is not likely to remain at 50s. a quarter—assuming it gets there—or even at its present price of 45s., the normal price will before very long be over 40s. per quarter. The late Mr. Clare Sewell Read—than whom there was no higher authority on wheat growing—told a Royal Commission some thirty years ago that it did not properly pay the English farmer to grow wheat for less than 42s. per quarter, and this opinion was never traversed by competent authority. But we must go back to 1883 to find wheat at over 40s. a quarter, and then it was only 41s. 9d. The consequence has been continuous shrinkage in the acreage under wheat. In 1875 the wheat acreage was 3,514,088; in 1885 it had fallen to 2,553,092; and in 1895, when the price had dropped to 23s. 1d. per imperial quarter, the acreage was only 1,339,806. With some recovery in price the acreage rose again in 1905 to 1,704,281 acres, but the improvement was not maintained, and in 1908 the acreage had again shrunk to 1,548,732 acres, the total production of wheat in the United Kingdom in that year being only 6,566,892 quarters, of an estimated value of £10,370,000, which means that the country has to import some 27,000,000 quarters to meet its requirements for the season ended July next. If instead of the low and unremunerative prices for wheat ruling in recent years the average stood again at over 40s.,

with likelihood of permanency at the higher rate, we should soon see an immense expansion of wheat cultivation in the United Kingdom, to the great benefit of the country. It is true that the loaf would be a little dearer than it has been during the last twenty years, but the disappearance of excessive cheapness would be much more than balanced by the check that would be given to migration to the towns. Competent opinion favours the view that we are not likely to see a return to the low prices of the nineties, and that it is not at all unlikely that the normal price of wheat will soon reach the figures given above, namely, 40s. per quarter, or over. For the supply of wheat is not likely to increase as rapidly as the demand for it. There is still a good deal of virgin soil available and suitable for wheat growing, but the wheat eating population of the world is very much larger than it was. To go no farther abroad than Germany, a generation ago the Germans were a rye-bread eating people, but now over 30 per cent. of the grain consumed is wheat. And whilst improvement in the material condition of people is leading to larger consumption of wheat, the United States, which hitherto have been the great exporters of wheat, will soon have little or none to export owing to the rapidly-growing requirements of their home market.

The Present Position.—It is commonly assumed that the wheat "corner," as it is called, in the United States is responsible for the recent rise in the price of wheat, namely, from 35s. to 45s. per quarter; but, although that has something to do with it, Mr. Patten and his associates represent only one, and the least important, of the factors to which the rise is due. Wheat is dear, and may become dearer because, whilst Europe will require during the next four months, that is, from now until the end of the season, some 20,000,000 quarters, it is not likely that the shipments will exceed 15,000,000. Assuming these figures to be approximately correct, there will be a shortage of about 5,000,000 quarters. This is taking normal requirements, but they will be reduced by economy in consumption due to high prices and the substitution of rye on the continent. When due allowance is made for these factors there will still remain a considerable shortage, which can only be made good by drawing upon stocks already greatly reduced. Taking the four years 1903-6, the normal consumption of wheat was estimated at about 405,000,000 quarters, and the world's production at about 411,000,000. Thus about 24,000,000 quarters were added to the world's stocks; but last year the world's production was put at about 382,000,000 quarters only, which greatly depleted the reserves, whilst this season's crop is put at 403,000,000 quarters with requirements amounting to 415,000,000 quarters or more. The Indian crop, which was expected to reach 40,000,000 quarters is not likely to exceed 35,000,000, the Argentine exports estimated at 13,500,000 quarters are not likely to exceed 11,500,000, of which 7,500,000 have already been shipped, and the American and Russian exports will not be up to expectations. These facts and figures go far to account not only for the present high wheat quotations but for the fear that prices may go higher, although probably it will be found that the available supplies are larger than at the moment they are assumed to be.

Naval Armaments and Trade.—It is an ill wind that blows nobody any good. Whilst social reformers are lamenting that increased expenditure upon armaments must delay indefinitely many of the measures intended to raise the economic condition of the people, one result of the expenditure must be the stimulus it will give to the iron, steel, engineering, copper, and coal trades, a stimulus that will not be confined to those trades, but will extend to other trades, until the whole industry of the country is affected by it. And what is true of this country will be true in lesser degree of the other leading countries of the world. It is estimated that for the next ten years we shall be spending something like twenty millions per annum upon the construction of Dreadnoughts and the subsidiary vessels necessary to an effective battle fleet, and not only Germany, but France, Russia, Italy, the United States, Japan, and even Austria and Spain, will be spending large sums in the reconstruction and augmentation of their fleets. This necessity for building new navies may be expected to result in quickening activity in every branch of trade.

The Present Unemployment.—The Board of Trade statistics of unemployment for March point to a slight improvement as compared with February, but it is very trifling—8·2 per cent. as compared with 8·4 per cent. In March of last year the percentage of the unemployed was only 6·4 per cent. But it would be a mistake to assume that last month's percentage as given above is a true index of labour conditions generally. The cotton, building, engineering, and shipbuilding trades account for a large section of the people regarding whom returns are made—the net membership of the 416 unions making returns was 700,654—and they were all suffering from very exceptional depression. As Mr. Beveridge points out in "Unemployment," an unemployed percentage of two for a year in a union of 10,000 might conceivably mean that 200 particular men were out of work and the other 9,800 in work the whole time or it might conceivably mean that every man of the 10,000 lost about one week in the year. Depression of trade is marked by very varying maxima. In the best years all the principal industrial groups alike tend to have about 2 per cent. unemployed. During the last twelve years the lowest figures recorded in the building trade were 0·8, in May, 1897; in the engineering trade 1·9, in January, 1897; in shipbuilding 1·4 in July, 1899. It is commonly supposed that unemployment is increasing, but the

weight of evidence is against this view. The exceptional distress of the present year may be parallelled in all essential particulars by the events of 1893-4, 1886, 1878-9, 1867, and earlier periods when the population was not much more than half what it is at present. The record of 10·7 per cent. for 1879 has never since been approached. If labour generally was becoming a drug in the market the return to labour would be diminishing; in fact, it is increasing. Taking the period 1878-1907 it will be found that there was substantial rise in rates of money wages in all the leading groups—including coal-mining, engineering, textile, agriculture—and concurrently there has been decrease in the cost of living. Official estimates put the decrease in the cost of living at 17 per cent. as between the five years from 1878 to 1882 and those from 1898 to 1902, and this has meant, of course, a corresponding rise in the value of every pound earned. Allowing for this change of values, according to Mr. Bowley's figures ("National Progress in Wealth and Trade," p. 33), the average real wages, as percentages of the level of 1900, were, in 1850, 50; in 1880, 70; in 1895, 93. Moreover, there has been a transference of labour from the lower paid to the more highly paid occupations. The present unemployment is sad, and great, but, contrasted with that of earlier years, it is by no means as great as the popular conception of it.

Farmers and Shops.—Shropshire farmers have decided to make a counter-move to the boycott by the National Meat Trades' Association of cattle offered for sale without a warranty. They intend to open competitive shops in the towns. The farmers of Newport and the district are already federated in a co-operative trading association, and it is thought to be feasible to add the retail sale of meat to the other activities of the Association. There is to be a conference of the Farmers' Associations in the adjoining counties to discuss the best means of carrying out the scheme.

CORRESPONDENCE.

DEW-PONDS.

I note in the *Journal* of the 9th inst. a further communication from Mr. George Hubbard on the above subject. I do not think a test on an insignificant scale, such as would seem to be implied by his letter, would be at all satisfactory or conclusive, and I am not personally inclined to find money on such an experimental operation.

I should welcome, as no doubt would Mr. Hubbard, the investigation of the subject by a small committee of some agricultural or other society, to be followed by a test installation. In another department of engineering practice, I am aware of a parallel case in which the necessary funds were obtained from a technical society interested in the point at issue.

It seems to me that some landowner who actually requires a water supply might opportunely join hands with an agricultural society for an installation such as I suggest, in the hope that scientific research might have a practical issue in the supply of water required on his estate.

Should my suggestion prove to be practicable, I should be quite prepared to take my due proportion of the financial risk. Should the landowner obtain his required supply of water, he would, I presume, be willing to pay a reasonable sum for the provision of the supply.

A. E. CAREY.

36, Victoria-street, S.W.,
15th April, 1909.

OBITUARY.

CÆSAR CZARNIKOW.—Mr. Cæsar Czarnikow, the well-known sugar broker, died suddenly at his residence in Eaton-square on the 17th inst. Although in the seventy-third year of his age, he had been engaged in business at his office until six o'clock on the evening preceding his decease, and his death, therefore, came as a great shock to his many friends in the City, and elsewhere. Mr. Czarnikow was a native of Sondershausen, in Germany, but he came to London when a young man, and after spending some time with a firm of brokers, he established a Colonial broker's business on his own account, which has grown under his able guidance into one of the largest of its kind in the world, having branches in New York, Glasgow, and Liverpool. Coffee and general goods were dealt in by the firm, but sugar was the product with which it was specially concerned, and Mr. Czarnikow was generally recognised as one of our principal authorities on all the difficult and thorny questions connected with the supply and consumption of this article. Mr. Czarnikow had been a Member of the Royal Society of Arts since 1901.

QUESTIONS AND ANSWERS.

NOTICES TO CORRESPONDENTS.

Readers in search of information which cannot be obtained from the usual sources are invited to make their wants known in the *Journal*, in the hope that they may be assisted in their difficulties by their fellow members.

On all communications must be written the name and address of the sender, not necessarily for

publication, but as a guarantee of good faith.

Each question or reply should be written on a separate sheet of paper, and should bear such signature of the writer and such address as he wishes to appear.

Questions which can be answered from the usual books of reference, will not be printed.

QUESTIONS.

DENE HOLES.—Can any further notes be contributed towards the elucidation of the mystery of our dene holes?—JOHN RYLE.

PRACTICAL APPLICATIONS OF HYDROGEN.—I was asked the other day what were the practical applications of hydrogen? I could think of none but the filling of balloons and the oxy-hydrogen light and blow-pipe. Are there any other industrial uses of the gas?—AERO.

FIRE WALKING.—I have just seen Mr. W. Coldstream's "Answer" in the *Journal* of April 2nd, and I am sure that many readers would feel as grateful as myself if he would kindly supply some of the "abundant testimony to the fact" of fire-walking in India, as well as Polynesia, of which he speaks. The whole subject is most curious, and, so far as I know, has never been scientifically investigated; but I am in hopes that we may yet receive some light on the subject when the *Journals* containing correspondence on this subject have had time to circulate among members in India and the South Seas.—MAORI.

SNAKE-STONES.—I should be glad of any information relating to snake-stones. What are they made of? And is their alleged effect on snake bites capable of any scientific explanation?—CEYLON.

EARTHENWARE FOR CLOTHING PURPOSES.—I am interested in the various uses to which ceramic products are put in the arts, and have been told that an Indian race used earthenware for clothing purposes. Having been unable to find a reference in the works on the subject, may I appeal to the members of the Royal Society of Arts, through our "Questions and Answers" column, which has already elicited so much useful information?—CERAMOS.

ANSWER.

VELLUM.—"Librarian" will find that benzine applied with a sponge will remove most stains from vellum without doing any injury to the texture.—H. LUCY.

GERMAN WHITAKER.—I know of no foreign work of reference that can be compared in excellence with Whitaker's Almanack. The best annual publication of this kind in Germany is probably Kurschner's Jahrbuch. It is published in Berlin, and the price is 1 mark. The book may be obtained through any foreign bookseller in London.—C.

NOTES ON BOOKS.

THE BOOK OF TRADE SECRETS. By an Expert. London: J. Haslam and Co., Ltd. 1s. net.

The intention of the author in compiling this little volume of recipes and instructions is to supply the collector of old MSS., books, and prints with information which will enable him to preserve his specimens and restore them to the best possible condition. Thus, *e.g.*, he gives instructions for the best means of preserving or restoring leather bindings, recipes for gum for labels, for destroying bookworms, &c. The title is explained by the statement that many of these recipes are "invaluable trade secrets," and the instructions include the most up-to-date methods practised by expert restorers. The various heads are arranged in alphabetical order, and reference is thereby made as easy as possible.

THE FERTILISATION OF TEA. By George A. Cowie, M.A. B.Sc. London: "Tropical Life" Publishing Department, John Bale, Sons, and Danielsson, Limited. 2s. 6d.

This book deals with the question of the cultivation of tea on modern and scientific lines. After an opening chapter on the tea-plant and tea-planting generally, the questions of pruning, soil, and the plant-foods necessary to secure good crops are carefully considered. "Green manuring" is discussed, and is followed by a chapter on artificial and chemical manures, and another on the best, *i.e.*, the most effective, and at the same time the safest and most economical, methods of applying this useful adjunct to the daily meal of the tea-plant, which is drawn from the soil to such an extent that no planter can afford to pass over the matter of replenishing the rapidly exhausted supplies as quickly as they are absorbed by the plant and removed by the leaves that form the crop. Unlike cacao, a tea-crop returns nothing to the soil; what is picked is lost for ever, and must be replaced. Two chapters towards the end of the book treat of the many experiments that have been made to enable the author and his fellow experts to ascertain the very best means of obtaining as large and as regular an output of tea as possible. Each method of fertilisation is brought forward and discussed; the various experiments to ascertain their respective merits are then explained, and finally the book winds up with a chapter on fertilising mixtures that should enable every planter, no matter how obstinate his soil may prove to be in responding to his efforts to increase his crop, to find at least one mixture that will bring about the desired result.

THE CEYLON HANDBOOK AND DIRECTORY.—Colombo: A. M. and J. Ferguson; London: Maclaren and Sons. 20s.

This annual volume, which has obtained a well deserved reputation in Ceylon as a compendium of useful information, is compiled and edited by the

staff of the *Ceylon Observer*, under the direction of Mr. J. Ferguson, C.M.G. It now contains over 1,500 closely-printed pages, which include, in addition to numerous directories and particulars about the public service, trade, public institutions, estates, &c., a statistical summaiy for the colony and a review of the planting industry up to July, 1908. Perhaps the most interesting feature in this connection is the rapid development of rubber cultivation. In March, 1898, it was estimated that the number of acres planted with rubber was 750; in 1904 this had risen to 11,000; in July, 1906, it had leapt up to 103,766; while the latest available returns place it at about 180,000. The acreage under tea is estimated at 392,000, and the exports of tea for 1908 at about 180,000,000 lbs. Great care has been taken to ensure the accuracy of the details given, which deal with an enormous variety of subjects, and the book should prove invaluable to all in search of statistical and reliable information concerning the island of Ceylon.

GENERAL NOTES.

Lectures on Weaving.—A course of six lectures on the "History and Technique of Weaving, with special reference to design," will be delivered by Mr. Luther Hooper at the London County Council Central School of Arts and Crafts, Southampton-row, W.C., on Friday evenings, April 23rd and 30th, and May 7th, 14th, 21st and 28th, at 8 p.m. The lectures will be fully illustrated with lantern slides and specimens, and will be free to students and others interested in weaving and design.

Association Litteraire et Artistique Internationale.—The forthcoming Congress of the Association Littéraire et Artistique will be held at the University of Copenhagen from June 21st to 26th. It will be organised under the patronage of H.M. the King of Denmark and the Danish Government. Among the principal subjects to be discussed are the report of the results of the Berlin Conference; the annual review of legislation relating to literary and artistic property; the unification of the duration of copyright; the literary and artistic rights in phonographs and cinematographs; the protection of architectural works, and the moral rights of authors. Persons desiring to attend the Congress should apply to M. A. Taillefer, General Secretary of the Association, 215 bis, Boulevard Saint Germain, Paris.

An Unemployed Census.—An interesting experiment has just been made in Manchester where an unemployed census has been made. This census demonstrates that nearly 19,000 men and women are out of regular employment in Manchester, and of these less than a quarter are earning anything by casual or partial employment. When account is taken of dependents the total number of persons affected cannot be much less than 50,000. Or to put it in another way, one person out of every twelve persons in Manchester is suffering from poverty due to loss of work. About 1,400 are disabled by disease. The immediate effect of these disclosures has been to lead the Distress Committee to rescind the resolution to close the relief works, and to make an application to the Local Government Board for a further grant to carry these works on past the 31st March, the end of the financial year.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

April 28.—"The Resources of the Peruvian Andes and Amazon." By C. Reginald Enock, F.R.G.S. Sir Clements Robert Markham, K.C.B., D.Sc., F.R.S., will preside.

May 5.—"English Furniture Design and Construction." By Percy A. Wells. Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D., will preside.

May 12.—"The Principles of Heredity as Applied to the Artificial Production of new forms of Plants and Animals." (Aldred Lecture.) By Professor Arthur Dendy, D.Sc., F.R.S., F.L.S.

May 19.—"Railway Development in China." By Arthur John Barry, M.Inst.C.E.

May 26.—"The Manufacture of Nitrate of Lime from Atmospheric Nitrogen." By Sam Eyde.

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

April 29.—"The Problem of Indian Labour Supply." By Selwyn Howe Fremantle, I.C.S. The Right Hon. Viscount Midleton, late Secretary of State for India, will preside.

May 13.—"Some Phases of Hinduism." By Krishna Gobinda Gupta (Member of the Council of India). Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D., will preside.

May 27.—"The Function of Schools of Art in India." By Cecil L. Burns, Principal of the Bombay School of Art. Professor Sir Hubert von Herkomer, C.V.O., D.C.L., R.A., will preside.

Colonial Section.

Tuesday afternoons, at 4.30 o'clock:—

May 18.—"Canada as a Field for British Investment." By J. Obed Smith, Assistant Superintendent of Emigration, Department of the Interior, Canada.

Cantor Lectures.

Monday evenings, at 8 o'clock:—

F. W. Lanchester, "Aerial Flight." Three Lectures.

Lecture I.—April 26.—*The principles of dynamic support*—The action of an inclined plane—The law of pressure reaction as a function of velocity—The law of pressure as a function of angle—Frictionless flight—The law of power expenditure as based on the laws of the pressure reaction—The laws of pressure reaction and power expenditure quantitatively considered: a discrepancy—The dipping front edge and its lesson—Cyclic motion in its relation to the supporting reaction—Direct evidences of cyclic motion—The quantitative treatment on the hypothesis of a cyclic component—The power expenditure under real conditions—Skin friction, its nature and magnitude—Skin friction as affecting power expenditure—Skin friction and other factors as limiting the wing area—Aeroplane *versus* pterygoid form—Meaning and influence of *aspect*—Importance of aspect ratio—The gliding angle, as measure of resistance—The minimum gliding angle as a function of the velocity of flight—The coefficient of skin-friction and the aspect ratio as affecting the value of the minimum gliding angle—The angle of inclination as related to the minimum gliding angle—The pressure proper to least resistance—The theory of screw propeller efficiency—Comparison of theoretical results with measurements of birds, flying machines, &c.—Controversy as to influence of skin-friction—Conclusions as affecting the problem of mechanical flight.

Lecture II.—May 3.—*The principles of stability*—The simple glider—The ballasted aeroplane—Form of the flight path as observed—The flight path as plotted from the equation—The phugoid chart and its teaching—Changes of amplitude of the phugoid curve and influences that lead to such changes—Conditions of flight path, stability and the equation of stability—Effects of propulsion on stability—Influence of the flexibility of the aerofoil—Lateral stability—Rotative stability—The stability of birds and of flying machines in practice—Flight path stability desirable but not essential to flight—Steering in altitude and azimuth—Gyroscopic couples—The boomerang—The gyroscope as an aid to stability.

Lecture III.—May 10.—*The Flying Machine.*—The function and uses of the flying machine—Possible types—The conditions to be fulfilled as defining the type—The need for high velocity—The difficulties of high velocity—The horse-power problem—Motors for flying machines and the conditions governing their weight—Fuels available and the relative importance of fuel economy—Propulsion and the propeller—The use of gearing—The limitations of flight as due to the mode of propulsion—Other modes of propulsion—Wing flapping and its efficiency—Soaring—Starting and alighting—Questions of design and construction—Steering and steering mechanism—Flying at a height—The advantages and disadvantages of altitude—Types of flying machine in practice—The future of flight—The flying machine as a mode of locomotion, in peace and war.

MEETINGS FOR THE ENSUING WEEK.

Monday, April 26... ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. F. W. Lanchester, "Aerial Flight." (Lecture I.)

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. E. H. Blake, "Some Notes on Warming and Ventilation."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. ("James Forrest" Lecture.) Colonel H. C. L. Holden, "Road Motors."

Tuesday, April 27... Royal Institution, Albemarle-street, W., 3 p.m. Prof. F. W. Mott, "The Brain in Relation to Right-Handedness and Speech." (Lecture II.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Annual General Meeting.

Statistical, 9, Adelphi-terrace, W.C., 5 p.m. Mr. W. R. Baldwin-Wiseman, "The Increase in the National Consumption of Water."

Photographic, 66, Russell-square, W.C., 8 p.m.

Faraday Society, 92, Victoria-street, S.W., 8 p.m. 1. Drs. F. G. Donnan and J. T. Barker, and Mr. B. P. Hill, "Experiments on the Current and Energy-Efficiencies of the Finlay Alkali Chlorine Cell." 2. Dr. Charles J. J. Fox, "The Coefficients of Absorption of Nitrogen and Oxygen in Distilled Water and Sea Water, and of Atmospheric Carbonic Acid in Sea Water." 3. Dr. Percy E. Spielmann, "The Electromotive Force of certain Platinum Compounds, with Special Reference to the Oxy-Hydrogen Gas Cell."

Wednesday, April 28... ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. C. Reginald Enock, "The Resources of the Peruvian Andes and Amazon."

Geological, Burlington-house, W., 8 p.m.

Japan Society, 20, Hanover-square, W., 8½ p.m. Mr. J. A. Lee, "Some Notes on Japanese Heraldry."

United Service Institution, Whitehall, S.W., 3 p.m. Mr. J. H. Anderson, "The Spanish Succession War in Spain, with special reference to the British Action."

Thursday, April 29... ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Mr. Selwyn Howe Fremantle, "The Problem of Indian Labour Supply."

Royal, Burlington-house, W., 4½ pm.

Antiquaries, Burlington-house, W., 8½ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. J. Paterson, "Aspects of Applied Aesthetics. (Lecture II.) Landscape, Old and New."

Friday, April 30... Royal Institution, Albemarle-street, W., 9 p.m. Mr. E. Gosse, "The Pitfalls of Biography."

Architectural Association, 18, Tufton-street, S.W., 7½ p.m. Mr. C. W. Smith, "Bruges—and the Neighbourhood."

Saturday, May 1... Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. T. Günther, "The Earth Movements of the Italian Coast and their Effects. (Lecture II.) 5 p.m., Annual Meeting

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FRIDAY, APRIL 30, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MAY 3, 8 p.m. (Cantor Lecture.) F. W. LANCHESTER, "Aerial Flight." (Lecture II.)

WEDNESDAY, MAY 5, 8 p.m. (Ordinary Meeting.) PERCY A. WELLS, "English Furniture Design and Construction."

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

On Monday evening, April 26th, Mr. F. W. LANCHESTER delivered the first lecture of his course on "Aerial Flight."

The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION.

On Thursday afternoon, April 29th, Mr. SELWYN HOWE FREMANTLE, I.C.S., read a paper on "The Problem of Indian Labour Supply." The RT. HON. VISCOUNT MIDLETON, late Secretary of State for India, presided.

The paper and discussion will be published in a subsequent number of the *Journal*.

CANTOR LECTURES ON CLOCKMAKING.

The Cantor Lectures on "The Theory and Practice of Clockmaking," by SIR HENRY HARDINGE CUNYNGHAME, K.C.B., have been reprinted from the *Journal*, and the pamphlet (price two shillings) can be obtained on application to the Secretary, Royal Society of Arts, John-street, Adelphi, London, W.C.

A full list of the Cantor Lectures, which have been published separately, and are still on sale, can be obtained on application.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

Tuesday afternoon, April 20; SIR GODFREY YEATMAN LAGDEN, K.C.M.G., in the chair.

The CHAIRMAN said he took the chair in the unavoidable and regrettable absence of Lord Brassey, and his first and pleasant duty was to introduce the reader of the paper. Mr. Murray, he said, was an old friend of his who had gained experience in several continents, having served in various capacities in the public service. Mr. Murray started his career in British New Guinea as Private Secretary to the Governor, and was afterwards made Resident Magistrate. During the South African war he had the good fortune of being transferred to the Transvaal, where, at the time the great work of rebuilding the fabric of Government was going on, great scope was afforded to his energy and ability. In the Transvaal Mr. Murray served in various capacities, one being as Native Commissioner, and in performing the functions of that office he had charge of a large population of natives, and had very responsible duties of a magisterial character. Later he was called home and appointed Private Secretary to the Under-Secretary of State for the Colonies. In all those spheres he had the opportunity of gaining most valuable information, and he had always shown a keen ambition to grasp the higher side of politics. It should be the aim of Great Britain to encourage young officers of that character to study Imperial questions, and, therefore, in the name of those present he offered to Mr. Murray a very warm welcome.

The paper read was—

THE ROAD TO SOUTH AFRICAN UNION.

BY THE HON. CHARLES GIDEON MURRAY.

I consider it a high privilege to address so distinguished a Society on a subject with which so many of its members must be intimately acquainted; but it is with considerable diffidence that I venture on the task, and more so,

looking to the fact that it is a subject which bristles with controversy at every turn. I shall, however, endeavour to deal with it in such a spirit as will not, I trust, infringe the traditional usage which has uniformly marked the submission of papers for your consideration. You may, perhaps, seek the ground on which I address you on a Colonial topic, and, therefore, by way of personal introduction, I may say that for the past ten years my official life has brought me into direct contact with Colonial problems in Australasia and South Africa. My task is rendered the more difficult because certain distinguished gentlemen well versed in South African affairs, among whom I might especially mention Sir Richard Solomon and Sir Lewis Michell, have recently delivered addresses on the subject of South Africa. They, I believe myself to be correct in saying, have confined themselves chiefly to an explanation of the terms and provisions of the Draft South African Constitution Bill. So far as I am aware, however, no address has yet been delivered dealing historically with outstanding features leading up to the present situation, nor indicating the ways in which physical conditions have gradually forced the South African people to combine in despite of all the strong political factors tending to produce unrest and disunion. I propose, therefore, to give you a short account of what I may call "The Road to South African Union." In doing so, I will refer to the Customs Conferences, the railway question (a perennial source of bitterness), the Defence Conference, and some other conferences. Incidentally I will tell you of the Inter-Colonial Council of the Transvaal and Orange River Colony, and I will touch upon one or two other factors in past war history of South Africa, the presence of which should tend to establish unification on a firmer basis than could otherwise have been the case. I also propose, if time allows, to end up with a brief survey of the racial question as between Briton and Boer.

With no insurmountable physical barriers, and, therefore, for natural reasons, a country suitable for one Government, the history of South Africa since 1837—the year of the big trek and the time of the liberation of the slaves in Cape Colony—has, until recently, been one of disunion. Separate State after separate State was proclaimed—first of all in 1854 the Orange Free State; then, in 1858, a number of communities established north of the Vaal River were consolidated into one republic, the Transvaal. Natal, in the year 1856, was given a constitution. In addition to these four main States, in 1884 Basutoland was declared a Protectorate under British sovereignty. In 1895 the Bechuanaland Protectorate was formally established. In 1889 that great Empire builder, Cecil Rhodes, took possession in the name of the Chartered Company of the large territory now known as Southern Rhodesia. There is also the native territory of Swaziland, which, in consequence of the extravagance of its late ruler, Umbandini, has recently been partitioned between the natives and the whites in order to satisfy the concessions which he so recklessly gave. This territory, as in the cases of Basutoland and Bechuanaland, is administered by a Resident Commissioner, who is responsible to the High Commissioner of South Africa. Then, lastly, there is the native territory of Zululand, which was in 1897 annexed to Natal and is no longer an entity of its own, although the influence of the Zulu race upon the history of South Africa, civilised and uncivilised, can never be obscured. Here then we have, together with Cape Colony, eight different States in one country, each State working out its own destiny locally and nationally on its own distinct lines, notwithstanding the fact that in every sense collaboration and combination was and is the only rational policy.

It is by no means in recent years alone that the policy of union, as opposed to disunion, has been regarded as one to be promoted in South Africa, for as early as 1857 Sir George Grey, one of the greatest of South Africa's Governors, wrote:—"By a Federal Union alone the South African Colonies can be made so strong and so united in policy and action that they can support themselves against the native tribes." In response to his efforts, the Orange Free State Volksraad in 1858 passed a resolution favouring a plan of Federation. The Imperial Government of the day, however, refused to sanction any step which might bring in its train increased responsibilities to themselves, and thus the first movement towards union was crushed and the policy of decentralization gained stronger root.

In 1876 Lord Carnarvon, who was then Colonial Secretary, induced the Imperial Government to pass an Act enabling the various Governments in South Africa to confederate whenever they desired to do so. The movement emanated from home and not from South Africa, and, therefore, nothing came of it. May I here interpolate the observation that

movements for federation or unification, whether in South Africa, the West Indies, or any other portion of His Majesty's wide dominions, can only succeed when they spring spontaneously from the people on the spot? Lord Carnarvon's failure has taught us to walk warily in constitutional experiments of so delicate a nature.

While other factors for disunion were increasing in number, the most marked of which was the jealousy created by the growing railway competition, there appeared on the horizon one bright ray of light. Justice and expediency demanded certain concessions to the inland States in rebates of Customs duties. As a consequence, the first Customs Conference assembled in 1888 at Cape Town, between representatives of Cape Colony, the Orange Free State, and Natal. This Conference achieved nothing, but in the following year another Conference met at Bloemfontein, which resulted in the establishment of a Customs union between Cape Colony and the Orange Free State. This was gradually extended to other States, and in January, 1899, before the late Transvaal War, a Customs union had been constituted between Cape Colony, the Orange Free State, Natal, Basutoland, and the Bechuanaland Protectorate. By the terms of this Union, goods which passed through the coast colonies to the Transvaal were subject to a transit rate. The war intervened; and here let me say that it is not my intention to make allusion to that particular period of South African history beyond stating as my view that the war and its settlement have brought within nearer range the unification of the South African States. In this respect I may also mention the grant of self-government to the Transvaal and the Orange River Colony, which, by the way, has gone far to dispel Boer distrust and suspicion of British government, and will enable a South African nation to be founded upon a basis of racial compromise rather than upon racial antagonism.

In 1903, as soon as the administrative reconstruction following on the war was progressing towards completion, a Customs Union Convention assembled at Bloemfontein under the presidency of Lord Milner. As a result, the Transvaal under her new Government entered the Customs Union, from which she had previously stood aloof, and, with Southern Rhodesia also included, there appeared for the first time a union of all British South Africa for one definite object. Transit rates were abolished, and the charge for collection of duties at the coastal ports was fixed at five per cent. This Conference is especially noteworthy, in that in addition to dealing with Customs matters it passed a resolution in favour of the formation of a South African Commission to gather accurate information on affairs relating to natives and their administration and to make recommendations. The resolution began with the words:—"That in view of the coming Federation of the South African Colonies . . ." The Commission was appointed under the chairmanship of Sir Godfrey Lagden, and issued the most valuable report on native affairs and policies which has ever seen the light in South Africa. This report has been published as a Parliamentary paper, and is accessible to all who may care to study it.

In 1906, at Pietermaritzburg, another Conference met in conclave, this time under the presidency of Lord Selborne, the present High Commissioner. During the three years which had elapsed since the previous Conference South Africa had passed through a most severe period of financial depression, from which she is now slowly but surely recovering. Her people were disheartened, local jealousies had become more acute, and the lack of fresh capital was throttling industrial enterprise. The natural tendency of the various States was to fight independently for their own hands irrespective of the interests of their neighbours. The delegates, however, realised the responsibility resting on their shoulders, and, entering into the Conference in a spirit of compromise and toleration, produced a workable convention. This convention was discussed in the different Legislatures in detail, but had to be passed or rejected as a whole, for the reason that the result of rejection in part by any State would probably have meant a Customs war. The convention was accepted by all Parliaments, and South Africa, by her sacrifice of local interests on the altar of national advancement, was now one step nearer unification. I may with some advantage ask you to compare the condition of Australia in respect to her Customs with that of South Africa. Prior to Federation, each State in Australia had its separate tariff. When the States federated themselves, they proceeded to prepare a Customs convention. In South Africa, however, this has already been done. Thus the local jealousies which in the case of Australia tended, during the preparation of the tariff, to subordinate Federal to State interests, will be in the case of South Africa practically eliminated.

As I before observed, the railway question has been a chief factor in the disunion of South Africa; though, to be perfectly fair, it may be said in another sense to have had also the opposite effect, for the issues which it has raised have been so grave, and led to such acrimonious controversy, that many people, in a position to judge, have long ago formed the opinion that the only possible solution of the problem is a complete amalgamation of the railways of British South Africa. While in 1873 there were only 63½ miles of railway, in 1885, owing to the discovery and opening up of the Kimberley diamond fields, that number had been increased to 1,498 miles. In 1886 the Transvaal goldfields were discovered. In May, 1892, the Cape Colonial section of the railway, which included lines from Port Elizabeth and East London, had, by arrangement with the Free State, reached Viljoen's Drift in the Vaal River, 30 miles from Johannesburg, and by September of the same year this line had been extended to Johannesburg by the Netherlands Railway Company. Cape Colony, owing to her agreement with the Orange Free State, was, from a railway point of view, in a much stronger position than Natal, who in the meantime had not been idle, and had also linked up by rail her port of Durban with Johannesburg. In 1894 the Delagoa Bay railway to Johannesburg was completed. This route is 89 miles shorter than that from Durban, and the Transvaal owns 341 miles of that railway, as against 178 miles on the Natal route and 49 miles on the Cape route. As an independent State, the Transvaal could hardly be expected to forego any of the advantages which she derived from this command over the Delagoa Bay line, and I often notice that the anti-federationists in the Transvaal of to-day are people who have been much influenced in taking up that attitude by the fear of losing any of those advantages. Since the moment of the completion of the Delagoa Bay Railway, the whole of the railway politics of South Africa have centred round that line. The Transvaal Government commenced by fixing rates which in a very short space of time acted detrimentally upon the transit trade of Cape Colony, and, in a lesser degree, upon that of Natal. Cape Colony, however, cannot in this instance be regarded altogether as the injured innocent, for she had not disdained to take advantage of her position at the expense of the Transvaalers when she commanded the only railway line from the coast to Johannesburg. Matters reached such a pass that in 1895 a Railway Conference was held at Cape Town, at which all the States were represented. The delegates at this Conference could come to no agreement and they separated without arriving at any solution of the important matters which had caused their assemblage. The Colony thereupon proceeded to have the goods which passed over her railways ridden by transport wagons from the Vaal River to Johannesburg, and so fixed the rates as to allow her lines to compete with Durban and Delagoa Bay. The Transvaal Government retaliated by closing the Drifts, and war nearly ensued, but this was averted by the intervention of the Home Government, who prevailed upon the Transvaal to reopen the Drifts. In 1897 the Orange Free State assumed control of the lines within her territory. Under this arrangement she fared so badly, her gross receipts from that source dropping from £1,043,835 in 1896 to £738,864 in 1898, that had it not been for the outbreak of the War in 1899 she would have been forced either to resume her railway alliance with Cape Colony or to have amalgamated her railway interests with the Transvaal. In either event a war of rates would have been almost inevitable.

On the 31st October, 1902, the British military authorities handed over the railways of the Transvaal and Orange River Colony to the Common Governor in whom they were vested by Order-in-Council. Lord Milner, with the goal of Federation ever before him, recognised the baneful effect upon this object which would result by allowing the two sets of railways to revert to their former separate existence. In advocating their retention as one system he wrote to Mr. Chamberlain in a memorandum dated the 5th February, 1903:—

"It would appear that as a pure matter of business the immediate sacrifice made by the Orange River Colony in respect of its railway revenue is more than compensated for by the ultimate advantages of partnership with the Transvaal, and by giving the latter an interest in the development of railways south of the Vaal, instead of its regarding such development with indifference or even hostility. And looking at the matter from a broader point of view—the point of view of the economic development of Central South Africa as a whole and the good relations between the two colonies—the substitution of a great common interest for conflicting local interests, the impulse given to co-operation and the advancement of the Federal principle, are calculated to be of infinite value not only to the two colonies but to their neighbours."

Shortly afterwards was created the Inter-Colonial Council, which was established by Order-in-Council, dated the 20th May, 1903.

Clause 4 of the Order tells us that the Council was established to advise the High Commissioner and Governor on certain matters, the more important of which were—(1) the financial administration of the Central South African Railways (the Central South African Railways being the railways of the Transvaal and Orange River Colony) and the employment of their revenue; (2) the expenditure on the South African Constabulary; (3) any matter connected with the administration of the Central South African Railways and the South African Constabulary or any other branch of the public service common to the Transvaal and the Orange River Colony.

The Council consisted of 14 nominated members with the High Commissioner as President. Of these members ten were official, while two were elected from amongst themselves by the unofficial members of the Legislative Council of the Transvaal, and the unofficial members of the Legislative Council of the Orange River Colony elected a similar number from amongst themselves. In this manner the business interests of each colony were represented on the Inter-Colonial Council. The creation of this Council was severely criticised by the public and the Press, each journal and individual attacking it from the standpoint of the particular colony and interest represented, and this continued up to the time when the Council was dissolved in June of last year. The Council, however, kept boldly on its way, and whatever criticism can be levelled at it in regard to its sacrifice of purely local interests, its records will always demonstrate the fair-mindedness of its decisions in connection with inter-colonial railway matters. In the early days of the Council, one of its most important duties was the control of the South African Constabulary, which involved an expenditure of close upon one million sterling per annum. This was a decreasing responsibility as the years passed by, for the number of that force was constantly being reduced and the expenditure in like proportion, and I may here observe that there is nothing extraordinary in this reduction in numbers, for as the country quieted down after the war, and gradually resumed its normal state, so did the necessity decrease for a large force of mounted constabulary. On the granting of self-government the control of the force was taken out of the hands of the Council and handed over to the two colonies. His Majesty's Government so far recognised the wisdom of Lord Milner's policy in promoting the creation of the Inter-Colonial Council that, on the grant of self-government to the Transvaal, they included a clause in the Act providing for its reconstitution and maintenance; but allowing for its abrogation in the event of six months' notice being given on either side after self-government had been granted to both colonies. This was as much as could have been done by the Home Government, and the action taken by the two Governments interested in determining the Council at the end of six months is not justly to be construed as a reflection on the policy, since the ground for it was a desire to be each in full possession of its own resources with the view to the coming of union, and since, though the Council was terminated, those of its functions which related to railways continued to be vested in a Railway Board representing both colonies.

And now let us pass to South African defence, a subject which has already occupied the attention of the various States—and which acquired special prominence at the time of and since the Natal (Zulu) Rebellion of 1905. I remember so well the outbreak of this rebellion. The Duke of Connaught was visiting South Africa. At a garden party given by the Mayor of Pretoria in honour of his Royal Highness, the news was whispered round that the natives had risen in Natal. Great, naturally, was the excitement amongst the soldier guests, who scented war, while the civilians, of whom I was one, could only ponder on the horrors of it, and think of the lonely farmsteads and the women and children who might be exposed to all the inhumanities of native warfare. But to what extent were the expectations of the soldiers to be fulfilled? I will tell you—by the despatch of half a battalion of the Cameron Highlanders to Pietermaritzburg, who were kept in that town as a garrison during the remainder of the rebellion. Natal had woke up to the fact that in the train of responsible Government had come responsibility for defence, and she was determined, if possible with her own resources, to quell the disturbances which so incontinently had arisen in her midst. This, as events turned out, she was unable to do, but her resolute efforts to achieve this object, watched with admiration by the other States, aroused in them a similar spirit of emulation. They stepped in with offers of men and supplies, and between them, and without recourse to

Imperial assistance, the rebellion was finally subdued.

The spirit which produced this united action was not allowed to die, for in January, 1907, at the instigation of the Cape Government, representatives of Cape Colony, the Transvaal, Natal, the Orange River Colony, and Southern Rhodesia, met at Johannesburg, under the presidency of Lord Selborne, to discuss the question of South African Defence. It will be sufficient for the purpose of this paper if I give you the wording of the first resolution passed at this Conference:—"That this Conference is of opinion that a scheme for the combined defence of the British South African Colonies should now be arrived at which may prepare the way for the ultimate federation of the defence forces of South Africa." The Conference then proceeded to draw up a scheme which, amongst other matters, provided that the terms of enrolment for all permanently paid Volunteer and Militia Forces should be for service anywhere in South Africa, and, further, that in the event of any war or disturbance arising in South Africa the colony which became engaged should, with certain provisos, have the right to requisition the other colonies for the assistance of such forces as might be provided for by the terms of her agreements. This Conference has not yet produced any tangible results, but the time is not far distant when we may hope that its labours will bear good fruit and be embodied in a "South African Defence Bill."

I have now attempted to outline some of the most salient points in connection with the growth of a Unified South Africa. In addition to the matters with which I have already dealt, it is necessary to bear in mind that Inter-Colonial Conferences have likewise been held, firstly, to discuss the establishment of a South African Court of Appeal—which by the way has taken shape in the Draft Constitution Bill—and, secondly, for the purpose of bringing the postal affairs of the different colonies into line. Similarly the force of geographical conditions produced joint action in other matters, perhaps relatively unimportant, but still of interest, such as joint survey, joint measures for eradication of stock diseases which never cease from troubling, and also joint measures for the destruction of locusts. All these Conferences afforded opportunities for a free exchange of views between leading representatives from each colony, not only on the points strictly within the terms of reference, but on many other subordinate matters, the prior discussion of which must have been of great assistance to the delegates, many of whom had taken part in those conferences in settling the terms of the Unification Bill. So complete is it proposed that this unification should be—and may I lay particular emphasis on this point?—that all revenues from whatever source arising, over which the several colonies have at the establishment of the Union power of appropriation, are under the terms of the Bill to be vested in the Governor General-in-Council, and to be administered by the Central Government. Two funds are to be formed—a Railway and Harbour fund, into which are to be paid all revenues accruing from the administration of the railways, ports, and harbours—and these revenues will be appropriated to those purposes alone—and, secondly, a Consolidated Reserve fund, for the receipt of all other revenues. The Central Government are also to assume all debts and liabilities of the various colonies, while all stocks, cash, bankers' balances, Crown lands, public works, and securities for money belonging to each of the colonies at the establishment of the Union are to become the property of the Union.

If I may trespass upon your patience for a short time longer, I should like to add a few remarks concerning the racial question between Briton and Boer, a question which cannot but have a very important bearing upon the future success or otherwise of a unified South Africa. I do not regard this question in the same—may I say despondent—light as do many of my compatriots both in South Africa and this country. There are few people, if any, who would be so bold as to attempt to argue that in the first and even the second South African Parliament the Boers will not be in a majority. But is this an argument against unification? Sir George Farrar, Mr. Lionel Phillips, and other gentlemen of well-known British sympathies, apparently do not think so. They have stood shoulder to shoulder with their Boer neighbours, and have strained every nerve to lay the foundations of a South African nation: and if they who have made the country their home are satisfied that their work will not be in vain, surely we may hope with them that Briton and Boer will work whole-heartedly together for the common good. I came across a few sentences in a letter by their own correspondent published in the *Morning Post* of the 13th of this month which so strongly supports this view that perhaps I may be per-

mitted to give you the extract verbatim. He says:—

"Opponents of Union on the British side have not hesitated to assert that the movement for Union is a plot for the permanent establishment of Afrikander power, and Britishers who have supported the scheme as calculated to promote the better government of the Empire have been branded as the miserable dupes of the Dutch. When, however, all the world knows that the old leader of Afrikanderdom, Mr. Jan Hofmeyer, is moving heaven and earth to prevent the Union of South Africa the absurdity of such charges is at once laid bare."

In considering this racial question, I often wondered whether its solution will be found either in the fusion of the two races, or in the influx of large numbers of immigrants from other countries; and I have come to the conclusion that it will be found in both. But the one which more particularly I wish to touch on to-day is the former.

I shall always remember the occasion upon which was brought home to me the first real glimpse of the possibility of the fusion of the two races. About a year and a half after the war I was travelling on official business through a lonely part of the Northern Transvaal, and had stopped for the night at a small wayside inn. During the evening two old Boer farmers came in for some refreshment, and sat talking together—in Dutch, of course—on the general situation. They talked quite loudly, and I could not but help overhearing what they were saying. In the course of their conversation one said to the other, "Are you sending your children to the English school" (meaning the Government school)? "Yes," said the other. "But," said the first, "why are you doing that? I personally will have nothing to do with the English or their language, nor will I allow my children to." "Oh," said the second Boer, "neither will I, but my children must, otherwise they will be handicapped in life, and I wish them to make money." How this little scrap of conversation opened my eyes to the fact that if the language question were tactfully and delicately handled, this, coupled with other factors to which I will shortly refer, would go far towards bringing the two races together. The Boers are an obstinate race of strong and tenacious opinions, who, if they had found that they were being compulsorily deprived of their language—which, however unliterary, they love—would have spared no effort not only to retain that language but also to injure the nation who had dared to attempt to accomplish its destruction. Lord Selborne recognised this, and in his famous Memorandum on Education, published in 1905, he embodied the principle of the dual language. It may interest you to know that this Memorandum formed the general basis of the Education Act which was passed by the Crown Colony Government of the Transvaal, and its principles were practically re-embodied in the subsequent Act passed after the grant of responsible government. The Memorandum aroused much adverse criticism at the time on the part of the extreme British section of the population, but its justification is to be found in the fact that it has enabled British and Boer children to study side by side in the Government schools. This principle of a dual language has been carried still further, for it has been introduced into the South African Unification Bill, and I personally consider that we need regard its inclusion with no greater suspicion than we do, for instance, the language question in Canada. I had the good fortune to travel in that rich and prosperous country last year, and found there a racial question which appeared to me to exceed anything I had witnessed in South Africa. While on that tour (in Canada) I was so fortunate as to have the opportunity of discussing the two racial questions with one of the most eminent statesmen of that country. And before I go any further let me say that the comparison which I am about to draw between the racial question as it exists in South Africa and as it exists in Canada to-day is made in no spirit of disparagement to Canada, for that country has by the powerful position which she has acquired for herself not only in the British Empire but in world at large placed herself without the range of any but favourable criticism. The statesman of whom I spoke pointed out to me that, whereas in Canada the French people lived mainly in the one Province of Quebec, had their own religion (Roman Catholicism), their own language (a literary one), all their local interests in common, sat on their Parish and Town Councils together, with no admixture of the British Canadian element; on the other hand, in South Africa the Britons and Boers lived side by side in all provinces. In South Africa there were certainly as in Canada two languages, but that of the Boers was an unliterary one; their religion was the same, while in Canada it was not; and, unlike Canada, their parochial and provincial affairs were bound to be considered from the point of view of the common good

for if not they only injured their own common interests. With all these factors for fusion of the two races he asked me how there could be distrust for the future of South Africa. Many of us, I believe, will live to see a South African nation under the British flag built up, not only on the basis of national harmony, but on a foundation from which all racial discord has been eliminated, and only the elements of unity and concord remain.

DISCUSSION.

The CHAIRMAN (Sir Godfrey Lagden) thanked the reader for his extremely interesting contribution, and thought that critics would find it very difficult to fulfil their mission in regard to the paper, as there was so little in it that persons conversant with South Africa could criticise. As the reader said, the question of South African union bristled with difficulties that had been existing for a great many years. He himself was in South African territory for the best part of thirty years, and the difficulties were bristling all the time he was there; people often talked about what Sir George Grey and Lord Carnarvon had done regarding Federation, what a hopeless failure it had been, and what a hopeless failure it was always going to be. That view, he was thankful to say, had now been dispelled, and he was quite certain that people in Great Britain, as well as in South Africa, would admire the way in which the question was approached by the statesmen who conceived the idea of promoting the last conference, and by the delegates who were appointed to discuss the problem. The only way success was achieved, was by the very fine spirit of compromise with which every one of those delegates entered the conference-hall. It had to be remembered also that the whole thing was done upon the initiative of the colonies themselves, and not by any inspiration received from the Government at home. The results were a great deal more than could have been expected by most people. If all the colonists were not satisfied that they had gained or would gain all they desired by the prospective union, he was certain that all agreed that the attempt to co-ordinate the views of the different colonies had been a very able one. Personally he thought there was no doubt that, just as the Act of Union, so far as it had gone, had been unanimously accepted in principle in South Africa, so in due time a solution or solutions would be found of all those differences of detail which at the present moment were being discussed throughout South Africa and in its Parliaments. One immediate result of the steps that had been taken to unify South Africa was the almost sudden disappearance of what was called racial feeling, and racial antipathy now seemed almost a thing of the past. Another great question in South Africa that had been affected by the conference was what was called the great native question. The native in South Africa for many years past had been looked upon as a hewer of wood and a drawer of water, very little better than an animal; but the time had come when the great leaders of South African thought had recognised that it was their imperative duty to provide for development, to guide and not suppress the legitimate aspirations of the native races in South Africa. That feeling had found a voice in the counsels of statesmen of South Africa in the conference that had lately been held; it was a manifestation to the people of South Africa of the importance of the question, and a manifestation to the native that the white man was not going to grind him down, but that if he behaved himself he would be well and fairly treated. There were many difficulties in the path of union. One remarkable feature that had struck him more than anything else was the rapid way in which so many of the difficulties had been removed since the first idea of holding the conference was mooted. As Sir Lewis Michell was present, he took the opportunity of congratulating him as a delegate of the conference, and as one who had for many years done so much to promote unity, and he also congratulated those in South Africa who had promoted a conference that led to such desirable results. If he interpreted the wishes of the audience aright, he thought it would be that they wished all success in future to the task the people of South Africa had set themselves of building up a great dominion of the British Empire.

The Hon. Sir LEWIS MICHELL said a great deal of spade work had been already done in connection with the question of union. Conferences had been held for many years past, and he himself had attended no less than six in addition to the Convention from which he had just come. In 1902 he attended on behalf of Cape Colony a conference at Pretoria on the subject of a mint. All parties much desired to have a uniform coinage, but the conference split on the subject of the head of the late Queen Victoria. He for his part was not prepared to remove that venerated head from the coinage and substitute that of Paul Kruger. The conference, therefore, came to nothing. There was also a conference on Colonial Defence and another conference on Uniform Joint Stock Law, the latter making a voluminous report, which was buried somewhere. There was also a customs conference in 1898, but it was found afterwards that the decisions of the various colonies at that conference were set at nought by the fact that there was no agreement as to railway rates, and, therefore, uniform customs rates were nullified by railway rates which were not uniform. In 1903 he attended a conference at Bloemfontein under the presidency of Lord Milner, to whom South Africa was so much indebted. That agreement lasted until 1906, when a new conference met at Bloemfontein under the presidency of Lord Selborne. Another agreement was arrived at, but it did not satisfy the various colonies, and a further meeting was

held in Pretoria in 1908 when nothing at all was effected. It was, therefore, decided that at a very early date the various self-governing colonies should meet in Durban to endeavour to arrive at union. That was a great step forward. The conference met on the 12th October last year and concluded its labours on the 3rd of February this year, and did a great work in drawing up the Draft Act of Union. That Act had since been submitted to the various Parliaments in South Africa and had been passed in the Transvaal and the Orange River Colony without any amendment, passed in Natal subject to a referendum, and passed at the Cape with various not very important amendments. On the 3rd of May the Convention would meet again in Bloemfontein to see whether they could harmonise the amendments, and if they could, as he thought was possible, the Prime Ministers of the self-governing colonies would visit England and ask the Imperial Government to make the Bill an Act of Parliament. It was said in some quarters that federation would be sufficient. The conference had before them the examples of Australia and Canada, the federation of the German Empire, and of the Swiss cantons, and after considering them had preferred the type of legislative union that was created by the union of England and Scotland, or perhaps some would prefer to say by the annexation of England by Scotland. It had been said that the conference should have been content with the example of Canada. On that point he would read a very short extract from the "Life of Sir John Macdonald," the maker of the Dominion of Canada, recently written by Dr. Parkin. In 1865 Sir John Macdonald said:—"I have again and again stated in the House that if practicable I thought a legislative union would be preferable. I have always contended that if we could agree to have one Government and one Parliament legislating for the whole of these peoples it would be the best, the cheapest, the most vigorous, and the strongest system we could adopt." That was the system adopted in South Africa, and under it the union of South Africa would be one of the brightest jewels in the crown of Great Britain. The united colonies would form a compact territory possessing much good land, a hardy population, and many valuable ports, and he was thankful to say a contented and loyal population. He was quite sure that if the union went through, and Great Britain was ever in want of assistance, she would obtain it from her sons of both races in South Africa.

The Hon. Sir J. LIEGE HULETT, M.L.A. (Natal), endorsed almost everything that had been said in the paper, but thought the reader made a little mistake in dating the formation of Natal as a British colony from 1856, because prior to that Natal had two Governors, Governor West and Governor Pine. In 1856 an elected Chamber was established in Natal by Governor Scott. He himself was a colonist of over fifty years, and was interested in the development of the material resources of a portion of South Africa. The legislative union of the various colonies was perhaps the most important event in the history of South Africa. He had been in favour of the union for very many years, and as a member of the Legislature for a quarter of a century had done all he possibly could to carry forward the spirit of union. In speaking to his constituency before leaving South Africa he endeavoured to impress upon them the necessity of accepting loyally the Draft Constitution. It was a different union from that which had taken place in Canada and in Australia. It might be said in one respect not to have sprung from the people but to have been forced upon them, but in another respect it had sprung from the people's representatives. The idea of union had been in the minds of the people, but its sudden coming was a matter of great surprise. No mandate had been given to the Conference on Customs which met at Pretoria in May last. Difficulties arose in various portions on Customs, and if the conference at Pretoria had broken up without doing anything chaos would have reigned from one end of South Africa to the other. But the delegates, as statesmen, considered that they were able to go beyond the bounds of their commission, and they proposed that a conference of representatives of all the States should meet in Durban for the consideration of the question. Every State was taken by surprise, but the objections raised were quietly calming down so that at the present moment the four Parliaments of South Africa had practically passed the Draft Bill. Certain objections had been raised in Natal and Cape Colony, but it would have been impossible to frame a Constitution that had no objectionable points. At the present moment the world was looking either at the birth of a nation or the blasting of a people's hopes. South Africa could not remain in the position it was now in. It was bound to go forward to legislative union. As a very old colonist he looked forward to a bright prospect in the material prosperity of the country. He believed no other portion of the world contained greater possibilities for a large and important nation to arise. The greatest difficulty that had to be contended with was the native question. As a Natal man, and a Minister of the Crown who had had the natives of the colony under his charge, he knew the weakness of the natives and their good points. The Chairman had done a very important work in South Africa in regard to the native question. There had been rebellions in Natal, but rebellions would not be likely to occur again if the united wisdom of a united South Africa dealt with the question. Natal was chiefly the British portion of South Africa, though there was an important Dutch population, amongst whom he had many friends. He was sure the racial question would gradually be eliminated as an important factor, because he believed both races were bent upon establishing upon a right basis a commonwealth of good-will one towards the other. The racial question would be settled much more quickly in the Transvaal and in the Orange River Colony than in

the other portions of South Africa, and probably the racial difficulty would be more slowly erased from men's minds in Cape Colony than in the region where there had been war, because the fact of the frightful war of the past had caused men to think, and when men began to think they would soon begin to act. There was not the same difficulty that was experienced in Canada. In South Africa the races were intermingled; in Canada they were distinctly separated. He was a loyal Briton, but he was heartily devoted to the Garden Colony of South Africa.

Mr. P. J. H. HANNON (late of the Department of Agriculture, Cape Colony) appreciated the paper because, he thought, in this country it was necessary to spread information about South Africa a great deal more at present than had been done in the past. He had been a good many years in South Africa, and had seen something of every side of the life of the country, and could not help feeling how much the people of Great Britain had to learn with regard to South African life and conditions. Personally he felt grateful to the reader for bringing out the great indebtedness of South Africa to Lord Milner for his splendid, statesmanlike work towards South African Union. When the history of South Africa came to be written from the inside, Lord Milner and those associated with him in the *régime* which followed the war would receive their full measure of credit. Anyone who had read the speech of the Chief Justice of Cape Colony, delivered some weeks ago, would see how small were the points that had been raised against union. The necessity now was to devote energy to carrying out the great work of development which must necessarily follow the accomplishment of union itself. As had been said, only those who had been in South Africa, and face to face with the possibilities of the country could have any idea of what could be done there when all its forces were co-ordinated.

The CHAIRMAN, in proposing a vote of thanks to Mr. Murray for his extremely interesting paper, said the meeting would be pleased to learn that quite recently Mr. Murray had been selected by the Colonial Office as Administrator of St. Vincent, and he hoped it would be a stepping-stone to greater things. In bidding Mr. Murray good-bye he was sure the meeting would join with him in wishing Mr. and Mrs. Murray all success and happiness and health in their new sphere of labour.

Sir JOHN CAMERON LAMB, C.B., C.M.G., seconded the motion and expressed his pleasure at the absence of controversial matter from the paper, which gave an excellent illustration of a saying of one of the Rothschilds, that compromise was the soul of business. Mr. Murray had shown how compromise had been the soul of business in South Africa, especially in connection with the Convention. A great deal was owing to our soldiers, because the way in which the war was carried on had helped very much to prepare the people in South Africa for the union. No war was carried on with less personal rancour or ill-will on either side.

The resolution was carried unanimously.

Mr. MURRAY thanked the Chairman for his kind remarks upon the paper, which were especially valuable, because Sir Godfrey Lagden had had a wide and extensive experience in South Africa, and had taken a leading part in many of the matters with which the paper dealt. He also thanked those who had taken part in the discussion.

Sir JOHN CAMERON LAMB expressed the thanks of the audience to the Chairman for the admirable manner in which he had conducted the discussion.

SEVENTEENTH ORDINARY MEETING.

Wednesday, April 28, 1909; Sir CLEMENTS R. MARKHAM, K.C.B., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Azam, Khan Saheb Khwajah Mohammud, Dilkosha-garden, Dacca, Eastern Bengal, India.
Clarke, Percy, 13, Fleet-street, E.C.
Goolamhusein, Khan Bahadur H. M. Malak Budrudin, Medhi Bay, Nagpur, India.
Greaves, Mrs., 58, Westbourne-park-road, W.
Guy, Frederic John Vavasour, M.P.S., Kuala Lumpur, Selangor, Federated Malay States.
Habakkuk, William, M.Inst.M.M., 459, Grande Rue, Pera, Constantinople, Turkey.
Hack, Walter P. Pearson, Khartoum, Soudan, Egypt.
Matson, Ralph C., M.D., 1021, Corbett-building, Portland, Oregon, U.S.A.
Menon, T. Kunhi Krishna, B.A., M.R.A.S., Ernakulam, Cochin State, Southern India.
Nakamura, Z., President, South Manchuria Railway Company, Dairen, China.
Nonomura, Kingoro, South Manchuria Railway Company, Dairen, China.
Pet, Maung, K.S.M., Konwindat Quarter, Tavoy, Burma.
Ridsdale, Herbert Wheatley, Hill House, Burnham-on-Crouch, Essex.
Robertson, Lieut.-Colonel D. K., 8, Cadogan-mansions, Sloane-square, S.W.
Sen, Bankim Chandra, M.R.A.S., Common Room, Lincoln's-inn., W.C.
Somake, Moses J. H., McLeod-road, Karachi, India.
Volckman, George William, 197, Sparks-street, Ottawa, Canada.

The following candidates were balloted for and duly elected members of the Society:—

Conn, W. J., Railway and Civil Engineer, State Railway, British North Borneo, Papar, *viâ* Jesselton, British North Borneo.

Greenwood, H. B., The Pacific and European Telegraph Company, Necochea 183, Mendoza, Argentina, South America.

The paper read was—

THE RESOURCES OF THE PERUVIAN ANDES AND AMAZON.

By C. Reginald Enock, F.R.G.S.,
Civil and Mining Engineer.

Peru, in the popular mind, has ever been a land of El Dorado. As we behold the country from the deck of the approaching steamer, visions of Pizarro and the untold gold of the Incas crowd upon us; and raising our eyes to that far, blue maritime Cordillera of the Andes, which arises to the east, we feel some of the charm of the Great Unknown which actuated the famous Conquistadores of that memorable age of ocean chivalry which followed the discovery of America. Beyond that great natural barrier of mountains, shutting off the blue Pacific Ocean and the deserts of the coast from the interior, lay the strange empire of the Incas; soon to fall before a handful of European adventurers. This was nearly four centuries ago.

What lies beyond it to-day? There are gold mines; untold wealth of silver; there is copper and coal and quicksilver in abundance; and farther on yet there is wealth of rubber and timber and chocolate and sugar-cane, great herds of sheep and cattle and alpacas, and many other matters of satisfaction to the traveller, the capitalist, and the merchant. Upon those high plateaux, miles above the level of the sea and beyond the serrated edge of the Andes, upon which we are looking, are the beautiful old stone temples and palaces of a prehistoric race, some of which rival in massiveness and ingenuity the famous monuments of Egypt. Upon that great roof of the South American world, whose outer edge alone is visible to us from the coast, are treasures such as might enrich a whole nation, and fill fleets of plate-ships such as Drake and the kings of Spain never dreamed of. I have met weary mules staggering under the weight of ingots of solid gold and silver, as they brushed against me on the mountain trails; whilst in my own saddle-bags were plates of gold and bags of gold-dust which I had won myself from the rivers and rocks of the Andes. And far beyond the great Cordilleras we shall see canoe-loads of "black gold," the rubber from the forests, as the rubber-gatherer shoots down the rapids of the Amazon affluents towards the Iquitos market. The wealth of an empire lies within and beyond the Andes and upon the Peruvian Amazon, waiting only the set of humanity that way to gather it in for humanity's use.

To form a comprehensive idea of that great part of Western South America which forms the Republic of Peru, its geographical character must be grasped. Peru is naturally divided into three zones—the coast, the mountains, and the forest regions respectively.

First is the coast. This is a semi-arid strip of land between the Andes and the ocean, some 1,400 miles long, from Ecuador in the north to Chile in the south. The coast is beaten with a tearing surf, and, whilst there are numerous ports at which the steamers call, only three or four of them—as Callao, Chimbole, and Payta—are first-class harbours, the others being open roadsteads. This coast zone varies in width up to about 90 miles, and is traversed by small rivers at great distances apart, which descend from the Andes to the sea. Between the cultivable lands and cities, which owe their existence to these streams, great arid deserts are encountered, for the Peruvian littoral is subject to the peculiar condition of having no appreciable rainfall, due mainly to the presence of the Andes, which mountains intercept the moisture-laden winds coming from the east.

Secondly, having crossed this coast-zone, we enter among the foot-hills of the Andes and ascend the slopes of the maritime Cordillera. The Andes consist of two, and in places three, main parallel chains, the summits of which are capped with perpetual snow. Between them, at high elevations above sea-level, are great plateaux, subject to heavy rainfall; and profound river-valleys, most of which have their outlet, not to the Pacific Ocean, only a hundred or two hundred miles away, but to the Amazon, and so to the Atlantic, three thousand miles away.

Thirdly, leaving these rugged and beautiful, if inclement, regions, we descend the eastern slope of the Andes and enter the boundless river and forest system of the basin of the Upper Amazon. This is a region of which large portions are still unexplored, and of

which parts are inhabited by tribes of savage Indians, and it is generally known as the "Montaña."

These three natural zones of coast, mountains, and forest, which I have traversed on repeated occasions, are exceedingly varied in all their conditions of topography, climate, and natural resources. The means of access to these last-named regions—an important point for consideration—must be considered difficult. But it is not to be expected that a country like Peru, traversed throughout its length by a great natural barrier of mountains, with passes generally at 15,000 or 16,000 feet above sea level, could yet be equipped very fully with roads and railways. Nevertheless two railways traverse the Andes, and others are projected or under construction. Of these two railways the northernmost is the famous Oroya line, which, leaving tide-water at Callao, passes through Lima and ascends the Andes to an elevation of 15,660 feet above sea-level—the highest railway in the world—and within one day the traveller is taken from the warm climate of the coast up to the region of perpetual snow. The other Peruvian trans-Andine railway is some 500 miles to the southward of the Oroya line. Leaving the port of Mollendo, it ascends to Arequipa and Lake Titicaca, crossing the Cordillera at an elevation of 14,660 feet above sea-level, and running thence to the famous old Inca capital of Cuzco. Beyond these two important routes of travel the remaining railways of Peru are short lines from the seaports, crossing the coast-zone and terminating at the base of the Andes. There is, however, an important branch line from Oroya to Cerro de Pasco, where a large new copper-producing industry has been set going of recent years. As to roads in Peru, there are practically none except the numerous mule-tracks, which give access to the towns and villages of the interior and the mines, and which are not practicable for vehicles. In some cases, as you journey along these roads, so precipitous are they, and so remarkably do they wind among the precipices and ravines, that the town to which you are journeying is seen thousands of feet below you, a day or more before you get there. Perhaps you encounter a train of laden mules just as you are passing one of these precipitous places, and some care is necessary to avoid being crowded off the path or injured by the packages they carry, which stick out on either side of them. It does not sooth your temper to be prodded in the leg with the corner of a sheet of corrugated iron, or a baulk of timber, or a bale of merchandise! However, the dangers and discomforts of the trail are often compensated for by the grandeur of the scenery and the interest of the journey, especially in the mountain regions. Nevertheless, conditions of travel in Peru, away from the lines of railway, must be looked upon as arduous and difficult, although they do not present necessarily impossible obstacles to development.

To turn now to a description of the natural resources and products of the country, it will be advisable to describe these as pertaining to the three respective zones of coast, mountains, and forests. In general terms, agriculture and matters pertaining thereto are a greater source of wealth at present than minerals and mining, notwithstanding the great wealth of minerals awaiting exploitation. Indeed, Peru has been likened to "a beggar sitting upon a pile of gold," the meaning of which is that the country's natural wealth is vast; but capital and enterprise for its extraction are lacking.

The principal source of wealth and industry on the coast-zone is the growing of the sugar-cane and the manufacture of sugar and rum; the growing and export of cotton; and the production of wine. The Peruvian planters claim a high yield of cane and sugar per acre from the soil, greater than that of Java, Hawaii, or Louisiana; and the yield is given in Government publications as several times greater than that of any of those famous districts. The sugar estates are generally situated on the margins of the rivers crossing the coast-zone, and are irrigated by means of canals from these rivers. Among the most productive valleys are those of Chicama, Trujillo, Chimbote and Santa in the north; the Rimac valley, near Lima; Cañete and the Tambo valley, further south. A good deal of British capital is invested in the production of sugar in this zone, generally with gratifying results; and many of the sugar estates, both Peruvian and British, are large and powerful concerns. Typical of the latter may be mentioned the Santa Barbara estate of the British Sugar Company, producing some 25,000 tons of sugar annually, and involving the constant upkeep of 10,000 acres of cane. On most of the estates large quantities of rum are manufactured, much of which is exported to the interior and to Bolivia. Unfortunately the consumption of alcohol among the Peruvian and Bolivian Indians is an increasing vice, and is beginning to have a markedly injurious effect upon the native

working population of the highlands. Upon these sugar estates, Japanese labourers are now being employed. Very few negroes, however, are encountered upon the littoral of Peru, and none whatever in the highlands, owing to the cold climate of the latter regions. Indeed, it is interesting to observe how Nature preserves the highlands of the Andes for the indigenous people. The negro will not go there, and the Chinaman is not plentiful. I once ascended from the hot coast-zone to the uplands, with a Peruvian negro mule-driver, whom I had employed, and his main desire was to finish the journey quickly, and get back to his warm village on the sands!

The sugar-cane flourishes up to an elevation —above sea-level—of 4,500 feet, on the Pacific slope. It is also cultivated, to a considerable extent, in the inter-andine valleys and the Montaña, or eastern slope, and is cultivated as high as 6,000 feet elevation. The average value in recent years of the sugar export of Peru has been about one and a-half million pounds sterling. The home consumption is about 30,000 tons per annum.

Cotton cultivation is an important industry in the coast-zone, the cotton being grown under irrigation. The plantations extend from the seashore to 60 miles inland, along some of the valleys, and the principal varieties grown are the Egyptian and the native kinds. Peruvian cottons are favourably known on the British market, especially the "full rough" and the "moderate rough," which are of excellent and unique qualities. The principal cotton-growing valleys are those of Piura, Lima, Ica, and Tambo de Mora. The annual value of the cotton export is in the neighbourhood of half-a-million sterling, and it is increasing; more land is being put under cultivation, owing to higher prices. There is some British capital invested in the production of cotton.

As regards the conditions of the coast-zone generally, it may be stated that the climate is good and temperate. Indeed, it is remarkable in this respect, as will be judged from the mean temperature, which ranges from 63° Fahr. in the south to 77° Fahr. in the north. No other country in the world in similar latitudes (3° to 19° S.) offers so cool a temperature, and the traveller coming from Panama and Guayaquil upon the same coast finds unexpected relief from the extreme heat of those places. Comparison between the Pacific coast of Peru and the Atlantic coast of Brazil in the same latitude shows a remarkable difference in favour of Peru, Lima giving an average of 66° Fahr. and Bahia 77° Fahr. This condition in Peru is due to the absence of moisture, the proximity of the Andes, and the existence of the Humbolt current.

Agriculture upon this coast-zone can only be extended by means of further irrigation works, and this calls for foreign capital, and offers a remunerative field for the employment of such, especially in cotton-growing. The cities and towns of the littoral are largely dependent for their means of subsistence upon produce brought in by steamers and schooners, and the growing population calls for extended cultivation. The establishing of cold-storage and chilled meat depôts, both in Peruvian and Chilean coast towns, ought to prove a paying enterprise, according to investigations I have made, as it would tend to regulate the great fluctuations in the price of meat and other provisions, for all cattle are imported or brought down from the interior.

The principal inhabitants of the animal world on the Peruvian coast are the myriads of web-footed sea birds—the palmipeds—the producers of the famous guano deposits, which have been so prominent a feature in the recent history of Peru. No nitrate beds of any importance have been found in Peruvian territory north of Tarapacá, and, indeed, the life of the Chilean deposits is generally estimated at about 40 years, although it is possible that this is much under-estimated. The resources of the Peruvian coast-zone must always be mainly agricultural, dependent entirely upon irrigation, which latter condition is by no means unfavourable, ensuring as it does a regularity in the crops. The area of land in this zone capable of such cultivation is estimated at 50 million acres, of which only 1½ millions are cultivated at present. Under the influence of water a large porton of the appalling deserts or pampas of this zone which, in some cases are as destitute of vegetation as the Sahara, can be turned into fruitful plantations, after the manner of California.

The next region to be considered is that of the Sierra—the slopes and highlands of the mighty Andes of Peru. We have heard much recently about Tibet. Peru, indeed, has been well termed the Tibet of America, and the analogy is very marked. Great mountain ranges, divided by high, bleak plateaux, profound valleys, lakes, and swamps, all crowned by the stupendous summits and peaks of the Cordilleras, with a crest of perpetual snow —such are the Andes of Peru and Bolivia. Beautiful, solitary, rigorous, are these vast high regions, and the gleaming, culminating

snow-clad peaks, tinged with the sunrise or sunset glow and piercing the blue heavens up to 20,000 feet above sea level, never fade entirely from the recollection of the traveller who has dwelt among them, or essayed their ascent. It fell to my lot to ascend and cross several snowy peaks and passes untrodden before by human foot. However, in Peru, instead of opposition to travel, as in Tibet, according to the accounts, hospitality is encountered, at any rate, among people of Spanish descent. On somé occasions, on arriving at a remote town and presenting my introductions—or even without such—the principal citizen of the place has prepard a feast for me and invited his friends, delighted at the advent of an Englishman on a scientific errand, in a place so cut off from the happenings of the outside world, and I retain pleasant recollections of their hospitality. On the other hand, among the Cholos and the Indians of some remote regions the greatest distrust and lack of hospitality is encountered, and nothing even in the way of necessary food can be purchased. In some of my long journeys into these places, on one or two occasions I have been obliged to go without food for days, except what little remained in the saddle bags, or to take it by force, leaving double its value in the hands of its protesting owners. This, however, is rare, and, as a rule, the Cholos of the most remote places are amenable to reason, once they know they are going to be treated with fairness, and not abused; and I have always told them that an Englishman, at least, always pays for what he takes!

On long prospecting expeditions I have found it well to live as much as possible on what the country passed through afforded, carrying of course, such essentials as tea, coffee, sugar, extract of beef, &c., in the saddle-bags of my men. Indeed, a few hints for intending travellers may not be out of place here; for on any tour of discovery, or examination of mining regions, reliance has to be placed much on one's own resources, as railways are soon left far behind. Such provisions as eggs, chickens, bread, or—failing that—toasted maize, potatoes, rice and fruit, can generally be purchased at the village, and in the cold regions, a sheep can be carried along on mule-back, and pieces cut off as required. No traveller will ever venture forth into the Peruvian interior without his own saddle, which he will purchase in Lima, an English saddle being quite unsuitable. An equally important part of his impedimenta is his folding-cot and bedding. On no account go without it if you intend to leave the line of railway. No great preparations for clothing are needed—an ordinary tweed riding suit and leather leggings and shooting boots are the main essentials, with a thick woollen poncho for the uplands and mountain regions, a thin white one for the coast deserts, and an indiarubber riding-cape for the rain. I know of no greater pleasure than, properly equipped, with all your worldly belongings securely packed upon a couple of pack-mules in charge of a careful mule-driver, to start forth into those little-known regions of Western America, there to discover what Nature holds of use for science and for commerce.

The uplands of the Andes are inhabited by the hardy Cholo race, the descendants of the Quechuas and the Aymaras, who formed the population of the Peruvian empire under the Incas. They live principally by agriculture and the raising of cattle, llamas, and alpacas, and the sale of wool, and also by mining. The singular and graceful llama, or American camel, is encountered everywhere near man's habitation in these high remote regions, and it forms the most valued possession of the poor Cholo, doing all his carrying trade and furnishing him, in conjunction with the alpaca, with the valuable commodity of wool, which is readily purchased for export to Liverpool. The annual value of the wool export is rather more than half a million sterling.

The Cholos and Indians inhabiting the Andine uplands—their habitat ranges from 7,000 to 17,000 feet or more in elevation above sea level—have retained one notable condition from their Inca progenitors: they are independent land-holders. Each Cholo and his family is the owner of a small holding, which he cultivates with alfalfa, maize, potatoes, or whatever product the position affords, thus supporting himself and his family in a way which renders him practically independent of the governing white Peruvian race. The Cholo asks little from civilisation, or at any rate from the civilisation of the Europeans, who destroyed that of his former Inca rulers, which was certainly not inferior to that which governs him at present. Indeed, the main blessings of modern civilisation, if such they may be termed, in those remote regions might be described in two words—priestcraft and alcohol! What these two words convey it is beyond the province of this paper to discuss.

The land system of these people is worthy of note, or at least the land laws under which they lived in the time of the Incas are, especially to-day in view of the question of small holdings in Britain. All the land was measured up and proper areas apportioned to every inhabitant, the area being increased as his family increased. They were obliged to work the land, and beggary, poverty, or destitution was not permitted, as every inhabitant was provided for and enjoyed his birthright of a piece of land, by the working of which he could maintain his family. Taxes to the Incas were payable in goods, not money, and in goods—as clothes, arms, or other matters—such as the particular district afforded. Indeed, so beneficent does the social system under the Incas appear to have been that it has given rise to the assertion that the primitive people of the Andes enjoyed a rule under their native princes such as has never been enjoyed by any Christian nation. To-day, all over the interminable slopes and valleys of the Andes these small holdings are encountered, abandoned in the greater part, owing to the extraordinary shrinkage of the population since the advent of the Spaniards. I have stood upon the summit of the hills as the sun cast shadows over their slopes, bringing into relief, with a singular chequered appearance, the innumerable small terraces, or "andenes," as these small holdings were termed, excavated on the upper, and banked up on the lower sides, to form flat places for cultivation. Many of these are used to-day, and the inhabitants of remote villages still elect their petty land-officials, whose duty it is to assign the use of the water in turn, for irrigation of the lands, as in the time of the Incas. But the greater part of them lie untenanted and abandoned, like the innumerable ruins of villages, cities, castles, and temples which the traveller encounters throughout this vast region of the Peruvian Sierra.

It is not within the province of this short paper to enter into a description of the great monuments in stone which have been left scattered about the uplands of the Andes, extending over many thousands of miles of territory. I have dwelt upon them fully in my books upon Peru.* The Incas cut and carried great monoliths and erected buildings of cut stone of such solid beauty as excite our admiration even to-day, as we look upon their ruins; and wonderful roads and bridges. There they stand, these ruins, in marked contrast to the flimsy adobe structures for the present occupiers of the land—temples, palaces, fortresses, and strange buildings of religious and astronomical purpose, and we may stand there amid their crumbling walls, and mark, as did the votive priests of old, the sun-god of the Incas as it sinks in the Occident.

These high, bleak tablelands of the Peruvian Andes are intersected by fertile valleys, which enjoy a delicious climate in many cases, with semi-tropical fruits and produce in abundance, and in these favoured spots the towns, which form the centres of the white or mixed population (as distinguished from the Cholos and indigenous red race), have their being. Most of these towns are much isolated from the coast and the outer world, their only means of communication being the ill-formed pack-mule trails, which wind interminably over the great punas or highland planes, cross deep valleys and precipitous-sided ravines and rapid rivers, and at times traverse mountain passes across the perpetual snow fields of the Cordilleras. Nevertheless, their inhabitants live in contentment; living is cheap; the struggle for life is less acute than in the manufacturing cities of North America or Europe; and the poorer Cholo or Indian of these regions is a far less trying spectacle than the pallid and starving slum-dweller of New York or London! Foreigners may journey and live in these regions with entire security; and with a very small capital at disposal can amass wealth and property, in mines, plantations, and commerce.

To turn now to these resources of Peru which ever have formed for the foreigner, and doubtless ever will form the most alluring field of work and enterprise—the mines. This vast region of the Andes embodies in Peru a mineral-bearing zone, 1,500 miles long and up to 500 miles wide; and within it every metal and mineral known to commerce is encountered. Silver, gold, copper, lead, quicksilver, coal, iron, zinc, petroleum, vanadium, molybdenite, bismuth, sulphur, nickel, cobalt, salt, and everything else are found and worked in Peru. Yet, notwithstanding this great wealth, the mineral industry at present is small relatively, although it is increasing rapidly, having triplicated itself since 1903. The value of the mineral and metal export annually at present is about three millions sterling. The backward position of mining is due to the lack of foreign capital, added to the

* "Peru" and "The Andes and the Amazon." London: T. Fisher Unwin.

slow development of means of communication, and to the fact that Peru has not generally enjoyed a favourable credit in European commercial centres—a condition, however, which is now being to some extent overcome.

I will now describe, as far as the limits of this paper will permit, the modes of occurrence and conditions for practical working of the principal minerals. The most widely distributed of these are gold, silver, copper, and coal. Gold occurs on both the western and eastern sides of the Peruvian Andes, although as alluvial or placer deposits only on the eastern side. Indeed, Peru may be looked upon as an exceedingly important source of gold for the world's future needs. For engineering and mining purposes the occurrence of Peruvian gold may be divided into three classes; and these, in the relative order of their importance for present working, are—first, the great banks and deposits of gold-bearing gravel for hydraulicking; second, the exceedingly numerous lodes of auriferous quartz; and third, the areas of gold-bearing deposits susceptible to dredging. There is no space here to go into the matter of the geological origin of the auriferous material, except to say that the existence of alluvial gold is due to the disintegration of innumerable gold-bearing lodes and veins which traversed, and still traverse the rocks of the great Cordilleras. Geological epochs of heavy rainfall and orographic change, especially under glacial action, have, as time went on, caused the disintegration of these rocks, the gold contained having accumulated in the bottoms of the great lakes which formerly existed in the Andine plateaux and valleys. A remaining instance of these is the great lake basin of Titicaca, which even to-day forms a hydrographic entity, with no outlet for its waters except that of evaporation. In some cases these enormous deposits of auriferous earth and gravel were subsequently upheaved by orographic change, and at the present time there exists a series of such deposits along the very summit of the Peruvian and Bolivian Andes, upon the actual water-parting of the continent, at elevations above sea-level of 15,000 to 18,000 feet. It is not to be supposed that the remarkable situation of these deposits renders them unworkable. Some of them which I have visited have been worked by the Indians for centuries, and in one or two cases modern hydraulic systems of "monitors" have been installed there. In some cases, as it is natural to suppose upon the water-parting, water is scarce and the climate is rigorous at this altitude. As giving an idea of the magnitude of these deposits of auriferous earth, it may be stated that a calculation has been made of a single one that it contains more gold than has ever come out of the whole of California.

Lower down on the eastern side of the Cordillera are some huge deposits of gold-bearing gravel under more favourable conditions for working, for at lower elevations there is abundant water and timber, whilst the climate is mild, and food products of any nature may be grown—conditions not encountered on the high summits. As an instance of these great auriferous deposits may be mentioned the mines of Aporoma, which I made a special expedition to examine. This great auriferous deposit is several miles in length and width, and it has been calculated that it contains gold to the value of £40,000,000 sterling, recoverable by the ordinary hydraulic methods. These mines were partly worked by the Incas before the advent of the Spaniards, and then by the brother of Pizarro. Later on, under one of the viceroys, works were constructed which cost £500,000, consisting of canals, aqueducts, tunnels under the ridges, sluiceways, &c. At present these are much overgrown with vegetation, but the situation of the deposit, with ample water supply and good conditions for the disposal of tailings, render it exceptionally favourable for working. The average value of the gravel, which was obtained by panning portions of the almost vertical faces of the huge banks, cut down for 500 or 1,000 feet deep by ravines, is about 2s. 6d. per ton of material.

On the eastern slope of the Peruvian Andes most of the rivers and streams are rich in alluvial gold, and the natives have a system of paving river-bars with stones in some places and recovering the gold annually brought down by the freshets. These are known as "gold farms." Whether upon the streams which flow into the great Madre de Dios river in the south of Peru, or whether those of the Marañon 600 or 700 miles to the north, both of which systems I have visited, gold is recovered in considerable quantities by the Indians in the form of dust and nuggets, and used as a medium of exchange in the villages. In my examination of some of these places I found the gold to be easily recoverable. I recollect one old Indian woman who lived in a hut on the top of a great bank of gravel, full of gold, who used sometimes to ask me, in her broken Spanish and Quechua, "Has the Señor found much gold to-day?" If I replied in the nega-

tive, she said, "Never mind, I will get you some," and taking her pan, formed of a big gourd, such as the Indians use for gold-washing, she disappeared into some ravine, known to herself, and in the course of an hour or so came back to present me with gold dust, varying in weight up to half an ounce, which she had washed out. Indeed, at certain seasons of the year, the Indians—men and women—leave their planting of maize and potatoes, and go gold-washing in the streams.

The areas of land susceptible to gold recovery by means of dredging, are very much lower down towards the Amazon plain, where the rivers have lost much of their velocity, and the very fine gold has been deposited in the silt. There is no doubt that an enormous quantity of gold must exist in this form, the work of the elements for ages, and some attempts recently have been made to take in gold dredges for recovering it. But this must be looked upon as extremely hazardous at present. A dredge is a heavy and complicated piece of machinery, and when it has been conveyed from the Pacific Coast up to the Andes and carried thereover and down into the montaña on mule-back and by Indians it is likely to suffer from the lack of repairing facilities in such a region. Moreover, the streams are subject to very sudden floods due to the tropical rainfall, and the few dredges which, so far, have been taken in have suffered disaster from being carried on to the rocks by sudden floods. Perhaps the region is too inaccessible yet for the successful operation of these machines, although the engineer and explorer is loath to think so. As to "hydraulic" mining of the deposits of gold-bearing gravel, of which I have already spoken, the conditions are more favourable, and no machinery at all is required for their working; nothing but iron pipes and nozzles.

We now come to the matter of gold-quartz lodes. These are exceedingly numerous, and are found throughout the country. In order that an exact idea may be formed of the value of such mines, I will give figures of some of those which I have examined, and which may be taken to some extent as typical:—In the southern part of the country is a group of gold-quartz lodes existing under favourable conditions for working. The ten main lodes or veins cross a deep valley, ascending the slopes and traversing a plateau on both sides. The outcrop of these lodes is from 2,000 to 3,000 feet above the lowest adit level on the valley floor, and the lode extends downwards to unknown depths. The lodes are traceable and have old workings upon them for a length of twelve miles, so that the dimensions of depth and length show the existence of a vast quantity of ore. As to the widths of the lodes, they vary up to eight feet generally, enclosing strong ore-bodies of good pay ore, whose value, as shown by the yield of workings extending over some years, may be taken at two ounces per ton, 70 per cent. of which is recoverable by amalgamation on the battery plates, and the balance by the usual methods from the pyrites with which it is associated. Thus the ore lends itself to relatively cheap mining by means of adit levels, whilst facilities both for water-power and for treatment are obtainable from the river, which flows near at hand. It is evidence of the backward state of mining in Peru, that, notwithstanding that this good district is at a distance of only 50 or 60 miles from the coast, it has remained neglected. Here is an opportunity for capitalists.

Another district has strong lodes up to 10 feet wide in places, whose ore values are 1½ ounces per ton. The ore is a smelting ore, carrying a high percentage of lead, and both water-power and coal are found close at hand. Yet another group of old mines contains 12 strong lodes, whose gold values range from two to seven ounces per ton, with high grades of silver, and these have been extensively worked at the surface, for miles in length, by native miners, who have extracted the ore from the upper or oxidised portion of the lodes, and have recovered the free gold by amalgamation in their primitive appliances. In other parts of Peru I have examined gold and silver lodes which carry pay ore in great bodies up to 150 feet in width, with external old workings, and these only require modern methods and appliances to yield up their wealth again. In yet another district is an almost inexhaustible area of gold-bearing conglomerate, averaging about three-quarters of an ounce to the ton. All that has been done in such countries as Mexico can be much more than duplicated in Peru, where nature has disposed things in the Andes on a much more stupendous scale.

As to silver, the hills of Peru are, in certain regions, literally honeycombed with old working upon rich lodes; and the Andes are dotted with ancient reduction works for recovering the white metal. From one district alone—Cerro de Pasco—silver was produced, from the end of the eighteenth to the end of the nine-

teenth centuries, to the value of £40,000,000; whilst the present output is somewhat under a million pounds. The present condition of many of these valuable Peruvian silver mines is that their workings are water-logged, and the native miner's resources do not generally permit them to spend money in long adit levels or pumping machinery for drainage. I have discovered and examined numerous mines of this nature—sometimes abandoned and without owners, open to anyone who chose to lay claim to them—which contain great bodies of rich silver ore, and the cost of draining and working these would be comparatively small. Great fortunes have been made almost by the stroke of a pick in Peru in the past in these silver mines, and conditions are much the same to-day. Probably no country in the world offers such exceptional conditions for those who are desirous of risking money in mining, and the expenditure of very large capital is not necessary. Generally speaking, all the elements of rich and abundant ore, proven lodes, water power, fuel, and cheap labour are to be found, and the only requisites are capital and management.

As regards copper, Peru may be expected to prove an important source of this metal when railways are extended into the regions where it occurs. The possibilities of Peruvian copper are being shown by the Cerro de Pasco deposits, to work which the American company has spent, it is stated, some fourteen million dollars. A line of railway, 80 miles long, and smelting furnaces of large capacity have been constructed, and are in operation; and the district has been pronounced by British and American experts to be the largest copper-ore deposit in the world. There are other copper-bearing districts, only of secondary importance, more remote, however, from lines of railway; for it is a peculiarity of Peru that no copper deposits of value are found near the coast.

Coal abounds throughout Peru. I have examined numerous strong seams of anthracite standing vertically, in some cases, with exposed outcrops, and crowning the hills for miles. As a rule, these have remained unworked, owing to difficulties of transport, but they form a valuable asset for the future. In one region exist hundreds of millions of tons of coal exposed at the surface. Short lines of railway from the coast are necessary to work these deposits. There are, in addition, important deposits of coal upon the coast, which have only been discovered the past few years, both in the northern and in the southern part of the country; in some cases extending under the sea.

Space forbids me to do more than mention the existence of the deposits of quicksilver ores, and the innumerable lead, zinc and other lodes and veins. The famous quicksilver mines of Peru yielded up a great revenue in past centuries to the Crown of Spain, and were pronounced by one of the viceroys as "one of the finest jewels of the Spanish Crown." I examined these important mines and consider their possibilities are very great. They might supply the world's market almost. In the northern part of Peru, near Tumbez, the petroleum wells are of considerable value: they are worked principally by British firms and the output finds a market in the country itself.

Leaving the high regions of the Andes we descend to the third natural zone of Peru, the "Montaña," or region of the forests of the Amazon plain. The natural resources of this vast region might be summed up by saying that it forms one of the world's great natural storehouses for the future. It is traversed by navigable streams and rivers in great part; all affluents of the Amazon. Of these waters 10,000 miles are navigable at all seasons of the year for steamers of varying draught, whilst in the wet season the total available navigable waters in rivers and streams, for steamers, launches, and canoes, exceeds 20,000 miles, all in Peruvian territory.

The main product of this wild region at present is rubber, of which the output is valued at about 1¼ millions sterling per annum. In the Peruvian montaña there are very extensive rubber-bearing forests, both in that part of the Amazon plain drained by the affluents of the Madre de Dios river, and, although less known, the region to the north drained by the Marañon and Huallaga. The principal Peruvian rubber-bearing trees are the Shiringa or Hevea, and the Caucho. The Hevea is the superior kind, and is that which has made Brazil famous as a rubber-producer. The tree requires a rich, deep soil and abundant moisture, and at times grows to great size. It lends itself to cultivation, although not much has been done in Peru yet in rubber-planting. Large areas of rubber-bearing land have been taken up in Peru, principally by Peruvians but partly by foreign companies, though much land still remains unoccupied.

Chocolate, sugar, cotton, cocaine, quinine, and a great variety of tropical fruits are also

produced. The possibilities for producing chocolate are very great. This region is one of the most fertile in the world; almost anything can be produced under cultivation; and instead of being the home, principally, of roving savages and monkeys it might be the centre of a great civilisation. As to the climate this in the higher region is healthy and pleasant. In the hot valleys of the lower region malaria is encountered, and this is always the greatest scourge, before drainage and ventilation are carried out. The principal drawback to the business of rubber collecting is the lack of labour, for, as regards transport, the waterways of the Amazon system afford means of outlet to Iquitos and thence to Europe or the United States down the Amazon. That the river port of Iquitos is destined to become of great importance, cannot be doubted. It is the commercial centre for the whole of this vast north-eastern region of the Peruvian montaña, and notwithstanding that it is 2,500 miles up the river, it is reached by the Liverpool steamers of the Booth line of 3,000 tons burden. The Amazon at Iquitos is three-quarters of a mile wide. One-tenth of the whole foreign trade of Peru is done with Iquitos, the main article of export being the rubber.

This vast territory of the Peruvian montaña is one which any nation might be proud to possess, but it is time it should be opened up to civilisation, and its natural resources turned to wealth. For this purpose railways are needed, and the construction of some is projected. Among the most important projects of this nature is one to unite the headwaters of the Peruvian Amazon, or Marañon, with the Pacific coast port of Payta, upon which I have been occupied for some time. The line has remarkable characteristics and possibilities. It will be only 400 miles long, yet it will create a new transcontinental route of trade and travel between the Atlantic and the Pacific seaboards—a route of which the 3,000 miles of the Amazon, navigable for steamships, forms the natural highway. The line will cross the Andes at the low elevation of 6,600 feet above sea level—the only low gap existing in the many thousands of miles of snow-bound Cordillera, which extend throughout Ecuador, Peru, and Chile. The important geographical conditions and the possibilities of the route across South America in its widest portion have never been brought forward before, and the fact that steam navigation from Europe can be carried on upon the Amazon, to within 260 miles of the Pacific coast, is not generally grasped.

To sum up, the natural resources of Peru are varied and abundant, and in many branches of industrial activity British capital can be profitably employed. At present British commerce with Peru greatly exceeds that of any other nation, and British interests control the principal railways of the country, whilst, as before stated, there is a good deal of British capital invested in sugar and cotton production. American and German activity and enterprise are, however, growing rapidly. In mining, British enterprise is not favourably marked so far, except in the old-established and well-equipped Casapalca smelting works. Some of the other mining enterprises of British origin have not done well, but the fault has been in mismanagement rather than in the mines themselves. Indeed, in some cases, these have been established under questionable native and foreign auspices, and have suffered in consequence, such as the gold mines, near Chimbote; the Recuay copper mines, and others. However, there can be no doubt that when the present lack of mining enterprise in London passes, attention will be turned to Peru and its stores of gold, silver, copper, and coal. Capital will then be drawn to investment there.

Directly affecting the resources of a country such as Peru, is the character of its inhabitants. The Peruvians, as a whole, are a hospitable and well-meaning people, with a cultured upper class. Since the loss of their nitrate wealth, they have shown some disposition towards taking off their coats, and going to work to develop their country, and, indeed, the great territory of Peru's mountain and forest region is of far higher value than the nitrate wealth of Tarapaca, whose life can be measured now by decades. The Peruvian upper class is a Spanish-speaking white and mixed race, but fond of ease; the women are attractive and vivacious. Lima has always been a centre of Spanish-American civilisation and culture inherited from the time of the viceroys. In their business methods the Peruvians as individuals have yet a good deal to learn, their greatest failing being the lack of rigid observance of word and bond; but they are a young nation with their future before them. More workers are the country's principal need, and more ideas from the outside. The small population of 3,000,000 souls—of which 50 per cent. are Cholos and Indians—inhabiting an area of 700,000 square miles, scarcely increases, and immigration at present is nil, notwithstanding the possibilities for immigrants. Remote from Europe, Peru

is one of those countries which may be expected to benefit by the Panama Canal, whenever that great work may be completed. The political and financial conditions of the country are good at present; the budget yields a surplus, and the best governing elements of the country are controlling the affairs of State, with the result that no revolution has occurred for 14 years. Knowing Peru and her people as perhaps few Englishmen know it, it has been for me a pleasure to respond to the invitation of the Royal Society of Arts to spread some wider knowledge of a country which is worthily striving to carry out its destiny in those splendid regions of the Pacific, the Andes, and the Amazon.

DISCUSSION.

The CHAIRMAN (Sir Clements Markham), in opening the discussion, said he had seldom listened to such an immense amount of valuable and interesting information condensed within so short a space of time, and the author had shown that he was just as apt with his pen as he was in travel and exploration. He was exceedingly pleased to hear Mr. Enock's reference to the hospitality of the people of Peru. Although he had travelled in a great many countries, he had never met with such hearty hospitality as he did throughout his journeys in Peru, both on the coast and in the interior. When travelling in the Montaña, he had to cut his way through the forests for weeks together, while he found the four young Indians who accompanied him as good companions as he could ever wish to have in work of the kind. Without their skill in cutting away the dense forests he could not have travelled through the country, and they were as good in encamping and as faithful to him as any men he had ever worked with. Although those events occurred many years ago, he looked back with pleasure on the intercourse he had had both with the upper classes of Peru and with the Indians.

Mr. H. HAMEL SMITH enquired about the nature of the labour available, and whether any would have to be imported, provided it was decided to cultivate rubber in Peru. It would also be of interest if information was forthcoming as to whether the cost of the land would be an important consideration in the question, and whether the transport of the rubber when it was grown would be a serious matter. Would it be possible to bring the produce down to the Pacific coast instead of, as at present, having to make the long journey down the Amazon to the Atlantic seaboard? Unless that was possible it would render the profitable cultivation of rubber in Peru quite hopeless, compared with the Federated Malay States and Ceylon, where the cost of transport was comparatively low. He understood that the rubber grown in Peru was of excellent quality, as it was in Bolivia, but the danger and expense of cultivating it was very great.

Miss WEBSTER thought the value of the paper would be increased if the author could give some particulars of the trees found in the forests. Were there any timber trees?

Mr. J. B. CARRUTHERS asked the author for information respecting the proportion of Para rubber trees in the natural jungle region he had described as rubber-producing, and what were the possibilities of extracting the rubber from them, apart altogether from the question of planting rubber.

Mr. E. T. SCAMMELL, in dealing with the question of the mineral resources of the country, said he had been struck with amazement to hear that such richly productive gold mines were in existence, and yet they had not been developed. If the facts with regard to the possibility of obtaining a two-ounce ore and even a seven-ounce ore were circulated far and wide, something might be done to develop such a great industry, although there was no doubt that the difficulties to be encountered were very great.

Mr. ENOCK, in reply, said that labour in the forest regions was rather scarce, and he believed some of the rubber companies engaged there had found that their main difficulty. Peru was anxious to introduce Japanese labour, a good deal of which was employed on the coast. The natural outlet of the rubber region was down the Amazon, because the rubber forests existed on the tributaries of that river. It had, nevertheless, been found cheaper by some of the companies working the rubber lands to bring the rubber over the Andes and down the railway to Mollendo. As soon as roads, perhaps motor roads, and short lines of railways were constructed on the natural outlet down the Amazon, he thought there would be an enormous development of trade. The Amazon forests possessed the peculiarity that they were unlike the other forests of the world, which consisted very largely of one kind of tree. They consisted of all kinds of trees, in fact he believed it had been calculated that in one square mile there existed thousands of different kinds of trees, and this rendered the Amazon forests perhaps of less value than some of the other forests of the world. If a particular kind of tree was required, it was sometimes necessary to hunt about for it a good deal. There were, however, great groves of what was termed cedar there, although it was not a true cedar; but it was a valuable wood. Valuable hard woods also grew in the forests. The question of the proportion of rubber trees to other trees was hard to answer. The rubber-bearing land was confined to a certain zone of land upon the margin of the rivers which were tributary to the Amazon; but it was impossible to state the exact proportion it

occupied of the total area. The political conditions of the country in years gone by were mainly responsible for the fact that the gold mines in the country had not been worked. The country had not had a good name, and, as a consequence, not much prospecting work had been done. But the condition of affairs was now very much altered. There was no doubt that the mines of Peru ought to be at the present time attractive to capital, because they could be obtained under very easy conditions, and in many cases they offered relatively easy methods of working. Peru might now be said to be in the condition of Mexico ten or twenty years ago, when many of the mines, which were now yielding enormous incomes to British companies, were practically going begging. The same state of affairs now existed in Peru, and the present was the opportunity for taking the mines up.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Mr. Enock for his interesting paper, and the meeting terminated.

PERSIAN CALICO.

A considerable trade is now being carried on in Persia, especially at Ispahan, in printed calico suitable for curtains for doors and windows, for tables and couches, and for wall hangings. The larger pieces are about twenty feet long by three feet or four feet wide, others about six feet by six feet, and many other sizes. The cotton cloth for printing is manufactured at Ispahan, although the foreign product is rather preferred. The designs are often exquisite, representations of flowers, peacocks with spread tail feathers, almonds, the tree of life (with or without leaves), leopards, elephants, lions, deer, and hunting scenes, in which the men are depicted as shooting arrows at wild boars; war scenes, which are extremely grotesque—large men on disproportionately small horses cleaving one another with great swords, splitting the body in two: important events of the national history, and countless other interesting designs. The American Consul at Ispahan says that in North-East Persia these are generally called "Kalamkars," and may be secured sometimes at the price of about 4s. per square yard. While the name by which they are known signifies "pen work," a stylus is used only in tracing delicate lines after the main design has been produced by the method of block printing. The block is of hard wood, containing in relief the design which is frequently repeated on the same piece. One block scores for only one colour, accordingly many blocks must be used in completing the design. Pieces of cotton cloth are first immersed in material contained in the intestines of sheep, drying and washing follow, and then they are kept for a time in a solution of gall nuts. Afterwards they are dried in the sun. To secure black colouring fluid, old rusty nails are kept for two or three weeks in water, which is occasionally stirred; the water is drawn off, a small quantity of castor oil and alum is added, and boiled down to a pasty consistency, this is then applied to the block. For red, some bol Armenian and alum are boiled with gum of the apricot or other trees contained in small muslin bags. The designs are for the most part in black and red. To secure blue, a paste of indigo and water is boiled, and to this are added some potash, lime, and grape syrup; blue is generally applied to the cloth hot. The main ingredient for yellow is pomegranate skin boiled with alum. After the application of the colours, the cotton fabric must be washed and spread out in the sun and frequently sprinkled. The above process ensures fast colours. When aniline dyes are employed the colours are almost invariably fugitive. Factories in Russia, and to some extent elsewhere in Europe, are producing cotton prints of Persian designs, and some of these are introduced even into Persia itself.

ANTWERP AND ITS SHIPPING.

Decline of British Trade.

The consular Report on the shipping and navigation of the port of Antwerp for the year 1908 is not very encouraging reading for Britishers. The year referred to was a particularly depressing and unsuccessful one from a commercial point of view, and the shipping trade, in common with many other industries, suffered from the lack of confidence in the financial world. Antwerp, like most other ports, has been hard hit of late years, and during the close of 1907 was in the throes of a labour strike; but notwithstanding this, there is some satisfaction in the fact that the returns for 1908 show but a small decline compared with those of the previous year. The most serious part of the business, though, for us is that the navigation returns for all shipping entering Antwerp showed a falling off in 1908, and that this decline is more than accounted for by the decrease of British shipping, both in the number of vessels and the aggregate tonnage. Not only was this the case, but the shipping trade of our commercial rivals increased. The foremost of them—need it be said—was Germany. The tonnage of German vessels visiting Antwerp has increased by 100 per cent. since 1900, while if one goes still further back, *i.e.*, to 1889, the contrast between her progress and that of our own country is still more striking. In that year the tonnage entering the port of Antwerp under the British as compared with that under the German flag was as 23 to 6, while last year the figures were as 5 to 3, a rate which seems to indicate that, within a measurable distance time, the German tonnage at this important port of Northern Europe will actually rival that of the United Kingdom.

HOME INDUSTRIES.

Railway Amalgamation.—The decision of the railway companies concerned—the Great Eastern, Great Northern, and Great Central railway companies —to withdraw the Bill authorising amalgamation will have occasioned but little surprise. The conditions under which the House of Commons consented to read the Bill a second time—and this only by a small majority—and the terms of the reference to the Select Committee, made it probable that the ultimate sanction of Parliament to amalgamation could only be obtained by concessions the companies were not prepared to make. The wide terms of the reference to the Committee—"to enable the whole case for amalgamation to be examined, not only with reference to the special interests affecting this particular Bill, but in the general and national interest"—would have made the inquiry costly and prolonged beyond precedent, and the labour troubles threatened in the event of the Bill passing through Parliament, probably had something to do with the decision of the companies not to go on with it. However that may be, the withdrawal of the Bill will be welcomed by the large number of traders and travellers who view such combinations, however carefully safeguarded by Parliament, with inveterate distrust, as inevitably tending to increased charges and restricted facilities. On the other hand, it will be regretted that the scheme embodied in the Bill, which would have afforded a valuable test of the extent to which retrenchments are possible under centralised administration can be carried without prejudice to the public interests, is dropped. It is possible, however, and even probable, that the companies have some alternative scheme for non-competitive working which will not require Parliamentary sanction, and which will enable them to put into operation many of the economies intended to be effected by the rejected Bill.

Alcoholic License Taxation.—It may or may not be the intention of the Chancellor of the Exchequer to propose an increase in the duties on licenses to sell alcoholic liquors—that will be known before this Note is read—nor is this the place to discuss the merits or otherwise of any such increase, but it may be of interest to note the course of license taxation, and how slight the changes have been since the first beer license duty was imposed in 1710, in the shape of a small stamp duty of one shilling. Forty-five years later it was raised to a guinea, and in 1810 to two guineas. As late as 1880 it was only two and a half guineas, while at the present time the annual license duty of a beerhouse proper is only £3 10s. per annum, while for a combined beer and wine license it is only £4 per annum. So with the publican's spirit license, in 1800 the average cost of a license to retail spirits was £5 1s. 6d., and in 1840 it was only 6s. 3d. more. In the next forty years there was no change. Indeed, in 1880, the average cost of a retail license for spirits was only £7 18s. 8d. as against £5 1s. 6d., in 1800. It was in 1880, that Mr. Gladstone introduced the "full" license, which allows the sale of any alcoholic liquor for "on" or "off" consumption. The range of duty was then extended from a minimum of £4 10s. for public houses under £10 annual value, to a maximum of £60 for houses of or above £700 annual value, and nothing has been done since 1880 to alter the scale. In the meantime there has been considerable restriction of licenses. Between 1880 and 1907-8 the number of publicans' licenses in the United Kingdom fell from 96,727, or 2·8 per 1,000 inhabitants, to 84,493, or 2·0 per 1,000 inhabitants, a decrease of 7 per cent. On the other hand, the estimated total expenditure on alcohol during the same period has risen from £145,500,000 to £167,000,000, or nearly 15 per cent. With 7,234 fewer public houses the expenditure on drink increased £21,500,000. The inequalities of incidence, too, are very marked. The same license of £60 is paid indifferently by all public houses rated at £700 and upwards. Between 1883 and 1908 the number of houses rated at £700 and upwards in England and Wales increased by 676, or 285 per cent. There are in London no fewer than 479 licensed public houses rated at £700 and upwards. Of these 74 are residential hotels possessing ordinary public house licenses. Their rateable value ranges from £700 to £31,000, but the license duty charged is the same, namely, £60.

Scotch Tweed.—Some months ago, reference was made in these Notes to the attempt to secure an official definition for Scotch tweed, but owing to the inability of the manufacturers to come to an agreement among themselves the movement is still in the stage of discussion. The definition originally suggested and adopted by the South of Scotland Chamber of Commerce in June, 1907, was "an all-wool cloth made in Scotland from yarn spun in Scotland," but last year a committee of the Chamber amended the proposed definition, so as to read, "A pure wool cloth made in Scotland, pure wool being wool which has not formed part of any woven or knitted fabric." At a special meeting of the Chamber to consider this proposed amendment, it was resolved to adhere to the original definition, it being considered that that definition was as good a guarantee of purity, and that in the event of further precautions, it would constitute a more workable standard. It has been objected to this resolution, and the dissent has been formally recorded, that it admits of the use of all kinds of woollen waste and recovered wool fibre, while it debars cloth from being described as Scotch tweed which has been sold as such for over forty years. Here the matter rests for the present, but there seems to be a growing desire in the trade to make another effort to obtain a definition which would be generally accepted. The difficulties in the way have, however, been greatly increased by the widely varying character of the fabrics manufactured in the south of Scotland, and the knotty point whether a worsted fabric is or is not a Scotch

tweed. Cheap Yorkshire cloths have become formidable competitors of the more costly Scottish tweeds, it being almost impossible for experts to detect the difference without an analysis, so close are the imitations.

The Production of Pig Iron.—The returns made by Iron Masters to the British Iron Trade Association show that the production of pig iron in the United Kingdom last year amounted to 9,289,840 tons as compared with 9,923,856 tons in 1907, and 10,149,383 tons in 1906. The decrease of 634,016 tons is the greatest recorded in any year since 1902.

Co-partnery.—In the course of a speech, delivered at West Hartlepool a few days ago, upon the occasion of the freedom of the burgh being conferred upon him, Sir Christopher Furness dwelt upon the formidable character of the foreign rivalry with which British manufacturers and traders have now to reckon, and expressed a confident opinion that nothing will enable it to be met successfully more than a system of co-partnery with its invaluable adjunct of a Work Council. Sir Christopher Furness would like to see it brought, in some form or other, into operation in every trade into which it can be made applicable throughout the kingdom. Impressed with the necessity for it, he suggests a national conference of the leading employers of the kingdom, in the hope and belief that a careful and sympathetic examination of the principle and practice of co-partnery would result in the adoption of a resolution to give effect thereto in the fashion, of course, best suited to the circumstances of each particular industry or trade. Such a determination would, he thinks, in the course of a few years not only transform the basis, but heighten the spirit and multiply enormously the resources of British industry and trade. "If," said Sir Christopher Furness, in words that deserve to be remembered, "we wish to maintain our supremacy, if we wish to lead the lives of self-respecting Englishmen worthy of the race from which we have sprung, we must doff the garb of frivolity, and cease to view life as a piece of play. We must throw off our personal self-conceit, and our national complacency, and become earnest students of our industrial aud commercial environment. We must manifest as never before initiative, zeal, energy, care, ability, industry. The best available instrument for meeting and overcoming this crisis in our national life is the principle of co-partnership."

Wheat and Meat.—It seems as if those who are responsible for the present attempt to "corner" the wheat market in America will fail as others have failed before them, high prices bringing out unexpected reserves. Prices have fallen considerably but there is no likelihood that for some time to come they will fall below paying quotations, and this for the reasons given in these Notes last week. The hope of a return to agricultural prosperity has never been so widespread since the price of wheat fell below 40s. per quarter, and although this country is never again likely to grow half the wheat it consumes, the acreage under wheat might quite conceivably be doubled, or even trebled, to the great advantage of the community. Meantime the dispute between the farmers and butchers as to meat warranty shows no signs of settlement. The butcher asks that he shall be relieved of loss with regard to animals which he buys in good faith at a fair market price and which, though apparently healthy, prove when slaughtered to be affected with disease. Farmers object because they consider it would be unjust to relieve the butcher of all risk at their expense, and to transfer his trade risk to their shoulders. The butcher wants the warranty not only to protect them against trade loss, but to lessen the risk of prosecution by the local authority, since it would give him the opportunity of proving his *bona fides.* It is admitted that butchers have a real grievance as to the existing law and practice with regard to want of uniformity in inspection, seizure, and condemnation of meat, and the manner in which prosecutions are sometimes instituted by the local authorities. A system of mutual insurance would seem to be the way out of the difficulty. Vendor and purchaser would then share the loss, but the Agricultural Committee are not at present prepared to go beyond the suggestion that vendors of stock should contribute to local butchers' insurance funds, a proposal considered inadequate by the butchers.

CORRESPONDENCE.

THE INTELLIGENCE OF THE ELEPHANT.

The very interesting paper in the *Journal* of the 16th inst., on "The Intelligence of Elephants" induces me to relate a fact which will tend to confirm the author's statements as to the animal's "intellectual power."

About forty years ago the late George Wombwell was travelling through the West Midlands with his famous show. The procession of caravans and animals was proceeding through the streets of the little town of Tenbury, when, within a short distance of the show ground, a fine Indian elephant (recently acquired at a cost, I believe, of about £1,000) caused a great commotion by suddenly "trumpeting" in an alarming manner and in a few moments was lying prostrate in the street. "Nellie"—for this was the elephant's name—had been seized with a fit of colic. A local "Vet." was soon found, in the person of a Mr. Turly, whose administrations enabled "Nellie" ultimately to be got on her feet and taken to a neighbouring stable. Here she received the careful and kind attention of Mr. Turly, who was successful in relieving the pain, and in four days she was

all right and proceeded to join the show in another town.

Seven years later Wombwell with "Nellie" again visited Tenbury, and as the procession made its way through the crowd "Nellie" suddenly raised her trumpeting voice and, leaving the procession, walked across the street to Mr. Turly, whom she had recognised, standing on the pavement. To the consternation of the people she quickly put her trunk around him, picked him up, gave him a couple of "gentle hugs," then placing him quietly down on his feet she marched back into the procession. After seven years she had not forgotten her benefactor. This fact in my opinion is not only confirmatory of the fine memory of the elephant; it also proves the ability of its intelligence to show gratitude and affection.

WILLIAM HOULSTON MORGAN.

Blakeney, Glos.

QUESTIONS AND ANSWERS.

NOTICES TO CORRESPONDENTS.

Readers in search of information which cannot be obtained from the usual sources are invited to make their wants known in the *Journal*, in the hope that they may be assisted in their difficulties by their fellow members.

On all communications must be written the name and address of the sender, not necessarily for publication, but as a guarantee of good faith.

Each question or reply should be written on a separate sheet of paper, and should bear such signature of the writer, and such address as he wishes to appear.

Questions which can be answered from the usual books of reference, will not be printed.

QUESTIONS.

CAUSTIC SODA.—A workman is making chemical manure, using caustic soda. He places this with water in a copper, but finds he has taken too much caustic. He returns this diluted overplus to a bottle-necked empty can and corks it up. In three days he thinks of using this again and lays the can on its side, taking out the cork. It is of the consistency of thick, slowly moving gum, with a crust formed on the surface. Standing a yard away he gets a receptacle for it to run into, when it bursts forth from the neck of the can as by an explosion full on the face and head of the workman, needless to say with serious consequences, disfiguring him for life, for it is of so sticky a nature as to render it difficult of quick removal. Can anyone explain the cause of this?—F. J. W. PLASKITT.

EARLY PATTERN OF ELECTRIC LAMP.—As far back as December 15, 1799, Thomas Grenville wrote from Stowe to Lord Grenville, who had a seat near Slough:—"I have this moment received an explanation of the electric lamp which I enclose for the evening amusement of all at Dropmore. Its cost—including packing—is just under five louis d'or." (Hist. MSS. Comm.: "Dropmore Papers," vi. 78.) Whose experimental lamp would this be? One of Volta's?—R. B.

ANSWERS.

EARTHENWARE FOR CLOTHING PURPOSES.—"Ceramos" is correct in his recollection as to the use of earthenware as an article of clothing. There was a tribe of Brazilian Indians, living on the island of Pacoval, at the mouth of the Amazon river, whose sole covering appears to have been a piece of pottery. These curious objects are called in Portuguese "tanga," that being the name of the small apron worn by savage tribes. The tanga was a curved piece of earthenware, of triangular contour and about the size of the hand. It was suspended like an apron by means of strings, for the attachment of which holes are provided in the three corners. The convex surface is elaborately ornamented; but, curiously enough, the design is not adapted to the shape of the article, but is broken off abruptly at the lower edges of the triangle. From the nature of the designs and the breaking of the continuity at the sides it would appear that the first tangas were made from the pieces of the earthenware vessels used by the same Indians. When they were afterwards specially made as an article of clothing the broken design was retained by the potter, as savage ladies do not so readily change their fashions as their more civilised sisters. "Ceramos" will find an excellent and well-illustrated article on the subject by Professor C. F. Hartt in the "Archivós do Museu Nacional do Rio de Janeiro," 1876, p. 21; there are specimens in the museums of Rio de Janeiro and Cornell University.—WALTER F. REID.

SNAKE-STONES.—There are several varieties of snake-stones, the majority of which have virtue attributed to them for which it would be difficult to find any scientific justification. They may be classed with the mascottes in vogue even at the present day amongst ourselves. There is one variety, however, which has some scientific justification. It is black and so porous that it adheres to the tongue. It is upon this porosity that its efficacy in case of snake bite depends. Placed upon an open wound it absorbs the blood with such avidity that it is quite possible the venom might be sucked out of a snake bite in this way. This kind of stone is really animal charcoal and may be made by heating a piece of ivory or stag horn, embedded in powdered charcoal, to a dull red heat. If, after repeated use, the porosity of the material diminishes, it may be restored by heating in this way. A much better material may be made of a kieselguhr composition, and I have made and used this successfully in treating bee stings. "Ceylon

will find that two things are absolutely necessary to ensure success with these materials: they must be applied as soon as possible, and the wound must be open so that an outward flow of blood can take place, carrying the poison with it.—WALTER F. REID.

NOTES ON BOOKS.

THE ANDES AND THE AMAZONS, 21s., and PERU, 10s. 6d. By C. Reginald Enock, F.R.G.S. London: T. Fisher Unwin.

In these two books, which have now run into several editions, Mr. Enock gives a graphic and exhaustive account of one of the most interesting countries in the world. The pages are packed with information of the most varied kinds, for the author's interests appear to be very many-sided, including alike history, geography, ethnography, zoology, botany, mining and engineering; and he seems to be equally at home whether estimating the enormous mineral resources of Peru, telling the terrible story of Pizarro, or describing the amazing stone-masonry of the Incas Nor does he fail in appreciation of the picturesque. His descriptions of the scenery, aided as they are by the many excellent photographs which illustrate the volumes, convey impressions of an extraordinarily beautiful country, which is, perhaps, none the less romantic and alluring because it is so difficult of access. Mr. Enock's style, too, is well suited for a book of travels: it is simple, yet vivid, and contains just enough of the personal note to make the reader feel that he is viewing the scenes described in the author's company.

THE RAT PROBLEM. By W. R. Boelter. London: John Bale, Ltd. 1909. 2s. 6d.

The author is one of the ounders of the Society for the Destruction of Vermin, and has given much attention to the question of the damage done by rats and its prevention. The book gives a history of the rat, an account of the various ways in which it injures health and property, an estimate of the pecuniary loss it inflicts on this country alone (stated as £15,000,000 per annum), and a description of the various methods proposed for its destruction. It advocates the passing of a law authorising the official extermination of the animal and providing means to this end.

PRACTICAL ORGANIC CHEMISTRY.—By J. J. Sudborough, Ph.D., D.Sc., F.I.C., and T. Campbell James, M.A., B.Sc. London: Blackie and Son. 5s. net.

This work differs from most laboratory text-books on organic chemistry in the large number of experiments which it describes. It deals not merely with the preparation of typical organic compounds, but includes typical preparations, equivalent and molecular weight determinations, and numerous quantitative experiments with carbon compounds, while some of the common physical methods used in the study of carbon compounds are also discussed. It is not expected by the authors that each experiment described should be performed by each student, but, in their opinion, greater interest is taken in laboratory work when different students are engaged upon different experiments. The book, which is written in a simple and lucid style, and illustrated with excellent diagrams, gives a comprehensive account of the subject, and a student who has mastered it should possess a sound knowledge of the rudiments of organic chemistry.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

MAY 5.—"English Furniture Design and Construction." By PERCY A. WELLS. SIR GEORGE BIRDWOOD, K.C.I.E., C.S.I., M.D., LL.D., will preside.

MAY 12.—"The Principles of Heredity as Applied to the Artificial Production of new forms of Plants and Animals." (Aldred Lecture.) By PROFESSOR ARTHUR DENDY, D.Sc., F.R.S., F.L.S.

MAY 19.—"Railway Development in China." By ARTHUR JOHN BARRY, M.Inst.C.E.

MAY 26.—"The Manufacture of Nitrate of Lime from Atmospheric Nitrogen." By SAM EYDE.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

MAY 13.—"Some Phases of Hinduism." By KRISHNA GOBINDA GUPTA (Member of the Council of India). SIR GEORGE BIRDWOOD, K.C.I.E., C.S.I., M.D., LL.D., will preside.

MAY 27.—"The Function of Schools of Art in India." By CECIL L. BURNS, Principal of the Bombay School of Art. PROFESSOR SIR HUBERT VON HERKOMER, C.V.O., D.C.L., R.A., will preside.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

MAY 18.—"Canada as a Field for British Investment." By J. OBED SMITH, Assistant Superintendent of Emigration, Department of the Interior, Canada. The RT. HON. LORD HINDLIP will preside.

Cantor Lectures.

Monday evenings, at 8 o'clock:—

F. W. Lanchester, "Aerial Flight." Three Lectures.

Lecture II.—May 3.—*The principles of stability* —The simple glider—The ballasted aeroplane—Form of the flight path as observed—The flight path as plotted from the equation—The phugoid chart and its teaching—Changes of amplitude of the phugoid curve and influences that lead to such changes—Conditions of flight path, stability and the equation of stability—Effects of propulsion on stability—Influence of the flexibility of the aerofoil—Lateral stability—Rotative stability—The stability of birds and of flying machines in practice—Flight path stability desirable but not essential to flight—Steering in altitude and azimuth—Gyroscopic couples—The boomerang—The gyroscope as an aid to stability.

Lecture III.—May 10.—*The Flying Machine.* —The function and uses of the flying machine—Possible types—The conditions to be fulfilled as defining the type—The need for high velocity—The difficulties of high velocity—The horse-power problem—Motors for flying machines and the conditions governing their weight—Fuels available and the relative importance of fuel economy—Propulsion and the propeller—The use of gearing—The limitations of flight as due to the mode of propulsion—Other modes of propulsion—Wing flapping and its efficiency—Soaring—Starting and alighting—Questions of design and construction—Steering and steering mechanism—Flying at a height—The advantages and disadvantages of altitude—Types of flying machine in practice—The future of flight—The flying machine as a mode of locomotion, in peace and war.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 3... ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. F. W. Lanchester, "Aerial Flight." (Lecture II.)

Farmers' Club, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Mr. A. D. Hall, "How Climate and Soil Influence Farm Crops."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7½ p.m. Mr. C. A. Battiscombe, "The Influence of Rainfall on the Design of Sewers."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. Clayton Beadle and Dr. H. P. Stevens, "Vulcanisation Tests in Plantation Rubbers." 2. Mr. H. H. Dains, "The Indian Magnesite Industry." 3. Mr. A. Girtler, "A New Steam Meter." 4. Mr. J. Lewkowitsch, "A New Refractometer."

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Colonel G. Mackinlay, "The Date of the Nativity was 8 B.C."

Tuesday, May 4...Royal Institution, Albemarle-street, W., 3 p.m. (Tyndale Lecture.) Professor S. Arrhenius, "Cosmogonical Questions." (Lecture I.)

Alpine Club, 23, Savile-row, W., 8½ p.m.

Wednesday, May 5...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Percy A. Wells, "English Furniture Design and Construction.

Dante Society, 38, Conduit-street, W. Dr. Alnigi Cossio, "Art in Danté."

Royal Archæological Institution, 20, Hanover-square, W., 4 p.m. 1. Professor W. Boyd Dawkins, "Prehistoric York, Durham, and Manchester." 2. Mr. R. Coltman Clephan, "The Early History of Gunpowder, and of the Hand-Gun."

Thursday, May 6...Electrical Engineers (at the House of the Royal Society of Arts, John-street, Adelphi, W.C.), 8 p.m. Mr. H. S. Hallo, "The Theory and Application of Motor Converters."

Royal, Burlington-house, W., 4½ pm.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mrs. Leonora J. Wilsmore, "Some Zoantheæ from Queensland and the New Hebrides." 2. Dr. V. E. Shelford, "The Oecological Relations of the Tiger-Beetles."

Chemical, Burlington-house, W., 8½ p.m. 1. Messrs. A. Findlay, W. E. S. Turner, and Miss G. E. Owen, "Affinity Constants of Hydroxyl- and Aikoxyl- Acids." 2. Mr. E. C. C. Baly, Miss K. A. Burke, and Miss E. G. Marsden, "The Absorption Spectra of the Nitrates in Relation to the Ionic Theory." 3. Messrs. W. J. Jones and K. J. P. Orten, "The Chlorination of Acetanilide." 4. Messrs. J. J. Sudborough and M. J. P. Davies, "Esterification Constants of Substituted Acryllic Acids. Part IV." 5. Mr. F. D. Chattaway, "The Action of the Halogens upon Aromatic Hydrazines." 6. Messrs. M. O. Forster and T. Thornley, "Studies in the Camphane Series." Part XXVI.—"Aryl Derivative of Iminocamphor." 7. Messrs. D. L. Chapman and P. S. MacMahon, "The Retarding Effect of Oxygen on the Rate of Interaction of Chlorine and Hydrogen." 8. Messrs. F. G. Donnan and W. Schneider, "The Colour of Aqueous Solutions of Violuric Acid." 9. Messrs. C. F. Cross and E. J. Bevan, "The Molecular Volumes and Solution Volumes of Colloidal Carbohydrates." 10. Mr. S. J. M. Auld, "An Examination of Irritant Woods. Part I. Chloroxylonine from East Indian Satinwood." 11. Messrs. A. W. Crossley and Miss N. Renouf, "Substituted Dihydrobenzenes." Part III. —"The so-called 1:1-dimethyl- Δ_{2}:5-cyclohexadiene of Harries and Antoni." 12. Messrs. N. L. Gebhard and H. B. Thompson, "Diaz-o-hydroxyl-amino Compounds and the Influence of Substituting Groups on the Stability of their Molecules."

Royal Institution, Albemarle-street, W., 3 p.m. "Aspects of Applied Aesthetics." Lecture III.—"Art and Ethics."

Civil and Mechanical Engineers, Caxton-hall, Westminster, S.W., 8 p.m. Mr. R. O. Wynne Roberts, "The Past, Present and Future of the Organisation of the Engineering Profession."

Friday, May 7...Royal Institution, Albemarle-street, W., 9 p.m. Major Ronald Ross, "The Campaign against Malaria."

Geologists' Association, University College, Gower street, W.C., 8 p.m. Rev. Charles Roger Bower and Mr. Joseph Richard Farmery, "The Lower Chalk of Lincolnshire."

Saturday, May 8...Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. Raleigh, "Edmund Burke."

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FRIDAY, MAY 7, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MAY 10, 8 p.m. (Cantor Lecture.) F. W. LANCHESTER, "Aerial Flight." (Lecture III.)

WEDNESDAY, MAY 12, 8 p.m. (Aldred Lecture.) PROFESSOR ARTHUR DENDY, D.Sc., F.R.S., F.L.S., "The Principles of Heredity as Applied to the Artificial Production of New Forms of Plants and Animals."

THURSDAY, MAY 13, 4.30 p.m. (Indian Section.) KRISHNA GOBINDA GUPTA (Member of the Council of India), "Some Phases of Hinduism."

Further particulars of the Society's meetings will be found at the end of this number.

CONVERSAZIONE.

The Society's Conversazione this year will take place at the Natural History Museum, Cromwell-road, S.W. (by permission of the Trustees of the British Museum), on Tuesday, June 29th, from 9 p.m. to 12.

The programme of the arrangements will be announced in a future number of the *Journal*.

CANTOR LECTURE.

On Monday evening, May 3rd, Mr. F. W. LANCHESTER delivered the second lecture of his course on "Aerial Flight."

The lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

EIGHTEENTH ORDINARY MEETING.

Wednesday, May 5, 1909; Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., M.D., LL.D., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Evans, Evan, A.M.I.E.E., Ryan-street, Stratford, Taranaki, New Zealand.
Lane, Frederick, Messrs. Lane and Macandrew, 26, Great St. Helens, E.C.
Mumm, Arnold Louis, 41 and 43, Maddox-street, Bond-street, W.
Perrott, William, B.Sc., Messrs. Johnson and Perrott, Ltd., Nelson-place, Cork, Ireland.

The following candidates were balloted for and duly elected members of the Society:—

de Voss, Mrs. Emilia V., 5, Eichenstrasse, Gross Flottbek, Holstein, Germany.
Forsyth, John Lloyd, West Rand Consolidated Mines, Limited, P.O. Box 38, Krugersdorp, Transvaal, South Africa.
Line, George, Messrs. John Line and Sons, Limited, 213-215, Tottenham Court-road, W.

The paper read was—

ENGLISH FURNITURE: ITS DESIGN AND CONSTRUCTION — ANCIENT AND MODERN.

By PERCY A. WELLS.

Before I show some examples of English furniture on the screen, I should like to say a few things about its production. The title of my paper covers a subject which, in recent years, has aroused a special and wide-spread interest, and received an attention not un-

worthy of its place in the decorative arts. It is satisfactory to feel that the furnishing and beautifying of a house has proved to be a subject of vital worth. Closely allied, as it is, and must always be, with the great mother art of architecture, it embodies some of the finest efforts and traditions of English craftsmanship. I venture to believe, and dare to hope, that those great traditions are not altogether lost; that they still inspire the work of to-day, and must continue to influence the work of the future. Whatever changes have taken place, or may come, the traditions behind a great craft must continue to hold the imagination of the workers in it, whether individual or collective, whether conscious of the fact or not. When that spirit is entirely lost, a craft must become debased, and barren, or cease to exist. I do not mean to say that we have not lost much which appears to be beyond the hope of recovery. Every period of change must bring a profit and loss account, but whether as an ideal to follow, or one to strive after, whether in the workmanship or the studio, these traditions are active forces which work for good or ill in the production of English furniture. It is by the power we possess of giving the highest and best interpretation to those traditions, that its position as a fine craft, and a great industry, must depend.

In furniture we can trace the changes in the social and individual life of the people. What we possess of five hundred years no doubt represents the "survival of the fittest." From the hutch, or chest, of the thirteenth and fourteenth centuries, we have a continuous and fertile growth. By itself, it was bed, seat, table and cupboard. Put upon legs it became the "court cupboard," cabinet, and sideboard. With a back it grew into a settle, settee, and sofa. With the ends lengthened and doors fitted, it lost itself in the press and the wardrobe. All these developments coincide with advances in craftsmanship, culture, and civilised life. In them we note the phases of production, from the primitive worker to the "Guild Brother," and from the "master-maker" to the factory. The work of each period was stamped with the tone and temper of the time, whether of native or foreign influence. Most of it was well designed, and constructed to suit its use. No article was too mean or unworthy of the best that the craftsman could put into it. This is a virtue we have undoubtedly lost, but I am not here to deplore the past, but rather to point its moral for the future, and to see how far it is possible with modern methods to keep alive and continue its best traditions.

We have reason to believe that the strongest and most effective factor in the early work was its more or less individual character, and that the workman had opportunities which he does not enjoy to-day. This, no doubt, was due in part to the lingering influence of the ancient "Guilds," as well as to the larger number of small masters, and the more stringent and all round training of the workman. It is, however, highly improbable that the actual worker was given an absolutely free hand, but it is possible that, having to make a complete piece of furniture from a rough sketch or drawing, his interpretation was more or less individual, as many of the country cabinetmakers must have interpreted Chippendale in the eighteenth century. In our estimation of the old work as against the new we too often forget the changed conditions, and are apt to blame the modern craftsman for many imperfections for which he is not alone responsible. Cabinet-making to-day is a much wider term than it was a hundred years ago. It is not confined to the making of ordinary articles for the house. We now have the most elaborate furnishing for ships and yachts; special furniture for hospitals, museums, and public buildings; all of which has called for as fine a skill as, and a greater resource than, the old workmen could possibly have shown.

From my experience as a craftsman, I can say that there are men in our modern workshops as skilful and intelligent as any in the old, but it has to be admitted that, owing to division of labour and the lessening opportunities of a good training, they constitute a vanishing number. In judging the workman the public are ignorant of the fact that he is not responsible for the design, and not always for the quality of the work, both of which are influenced by conditions over which he has no control. In the manufacture of furniture there are now the designer, the machine, and the workman. It is unfortunate that the workman comes last, for in many cases he is but the finisher of what the machine has done; but, against this, I should like to emphasise the fact that there must always be a great quantity of work which can only be done by hand, with a consequent demand for capable craftsmen.

It may be said here, that modern construction, in the best work, is as good as it can be, and, like the old, it meets the needs and uses of the age for which it is made. We do not need the heavy construction and open joints

of Elizabethan work. A good cabinet-maker of to-day has to make an equally strong joint without showing it.

In broad terms, the furniture being produced now, may be divided into three characteristic classes:—(1) The actual reproduction of historic examples; (2) designs based upon work of past periods; and (3) new work, more or less original, which may be termed "modern." I shall hope to show examples of all these on the screen. The first is a direct result of the revival of Georgian architecture with a demand for furniture in character with it. In the finest work of this kind, the demand must be limited. No pains are spared to make the reproductions as perfect as they can be. In the preparation of designs for decorated or panelled rooms, expensive models are made to ensure the right proportions and correct setting of the details. Commissions for English work of this type come from almost all parts of the world. The best men are engaged upon it, and here it is that they do not compare favourably with the old workmen. The construction is equally good, and probably better, but there is a marked weakness in the form and modelling of curves and shaped sections. Only the other day, the head of a large business house in the West-end showed me some chairs which had come straight from the workshop, and, compared with the model from which they were made, the form and outline were unpleasant to the touch, and did not satisfy the eye. The finish and beauty of outline in a chair is either made or marred by the workman, for the machine can only rough it out. It is just this quality—this quick perception of good form and line—which the old craftsman possessed and the modern one lacks. It is not a question of time or cost, for it takes as long to make a bad curve as it does a good one. It is not all the workman's fault, and it would be difficult to lay a finger exactly on the weak spot, but if English craftsmanship is to hold its own, something must be done to reclaim this essential feature. However highly skilled this work of reproduction may be, it has, I think, one fatal drawback. There is no element of growth in it; it does not stimulate the imagination or tend to progress in art or craft. There is another side to it which is distinctly unpleasant and dangerous to all concerned. The craze for antiques has seriously checked the desire for good modern work, and worst of all it has produced the "faker." Masters and workmen have been driven to this wretched business by the unfortunate whims and fancies of an ill-advised public, and the demands of dealers. Whether good or bad, if it looks anything like Chippendale or Queen Anne, there appears to be a sale for it. Some of it is so cleverly done that even experts are sometimes taken in. There is, however, a clear distinction between a copy of an old example which is frankly a reproduction, and a "faked up" piece which is done to deceive.

On the other hand there is much to be said for that portion of the public who, desiring good furniture, have felt compelled to go to the seventeenth or eighteenth centuries for it. To some extent the designers or makers are to blame for this. The number of people who travel, or who can acquire good taste in furniture, must be comparatively small, and it is to the originators—the designers—that we should look for a lead in this direction. They alone are responsible for the character and style of work put upon the market, and if they wish to lift the trade out of this demoralising business they must be prepared to put something better in its place. Is it not possible to educate the public through the furniture? The great mass of people have no choice but to buy what is put in front of them, and the trade has mistaken a demand for a certain class of work for a change of taste, when no question of taste has been concerned in it.

In the second division we have furniture of all kinds, the designs of which have been influenced by the work of past periods or "styles." And to what a wealth of work may our designers go for their models!—the strong and simple oak examples of the sixteenth and sevententh centuries—the delightful and homely pieces of the Dutch period—and the varied designs of the eighteenth century masters, all of them showing those classic, Italian, or French, influences which were remodelled and fashioned by the English craftsmen for English uses. In them we may discover the essential principles upon which furniture should be made—good proportion, sound construction, right use of material, thoughtful application of ornament, and utility. It is the modern designer's task and privilege to take up those traditions, and use them and adapt them to the needs and conditions of to-day. The materials are more varied than they were a hundred years ago. The construction is better, the machine has to be reckoned with, but it should serve and not dictate, and I think that all round the

opportunities are greater. We have but to take the modern house, either large or small, for change and variety in each room. The question of cost can only affect the quality of material, construction, and finish. Good proportions, good lines, pleasant colour and fitness for its purpose, are features which go to make furniture beautiful, and lift it out of the lower but essential position of bare utility. These features can and should be given to all furniture. They would not cost as much as the overloaded detail and meretricious ornament which has made the bulk of our furniture so commonplace and ugly. They are the very qualities which we admire so much in the old work, and, as they represent principles which only change in their application, I believe it is possible to have them in the new.

Under the third division we have seen an attempt to throw over all tradition, to defy right principles of construction, and to make an improper use of material. I should not have mentioned the "New Art" phase except to show that any movement based upon such lines is doomed to fail. In England it did not go to such extremes as were seen on the Continent, but for a time it had a most baneful influence on the trade. The desire to return to simpler forms was a highly commendable one, and in the hands of thoughtful men it should have given a healthy tone and vigorous lead to better work; but, with some rare and excellent exceptions, the reverse has been the case. Through this movement it was possible to produce the most distasteful and eccentric furniture ever put upon the market. It lent itself to the worst form of cheapness, and was foisted upon the purchaser as an "art" revival. When it is realised that the greater quantity of made-up furniture goes into the ever increasing number of small houses, it is deplorable to think of this wasted opportunity whereby some degree of good taste might have been brought into the homes of the people.

The term "modern," in furniture design, is somewhat vague, and is loosely used to distinguish a type of work largely influenced by the splendid pioneer efforts of the "Arts and Crafts Society." Most of it shows some attempt at original treatment of old forms, with a revival of the simpler types of decoration such as inlaying. A considerable amount of furniture has been designed and made by individual members of the Society, or by "Guilds" of craftsmen, founded upon its principles. Much of it is very good, but in some instances the desire to be original has been carried beyond the bounds of reason. Its influence in the trade has been somewhat limited, but where it has been handled in the right spirit, some excellent furniture has been produced, whilst in the cheaper kinds it has developed into a "shoddy" apology for simplicity.

It is still open for our designers to supply good cottage furniture—by good, I mean simple and strong—as good as the examples now to be found adorning the drawing-rooms of cultured people. These cottage articles have been exchanged for "plush" or "saddle-bag" chairs and flimsy chests, which dazzle the eyes of the poor cottager, and make him only too ready to give up his plainer-looking, though better, things. At the Garden City Exhibition we saw an attempt to furnish cottages, and it must be confessed it was more than disappointing. Only one firm had noted the fact that the most important article in a cottager's living-room was either a bureau or a chest of drawers. As the Yorkshire dresser is in the North, so is the chest of drawers in the South, and I shall be glad to show you a chest designed by Mr. Ambrose Heal which appears to answer the purpose admirably; and to this might be added some bedroom and living-room articles. People who have week-end cottages can usually find suitable furniture for them, but it is something of a crime to rob the real cottager by an exchange which leaves him poorer, and makes him poorer still within six months of the bargain, when he has no chairs to sit upon.

From these conclusions it would appear that the greatest opportunities for progress and betterment—so far as it affects the trade as a whole—are contained in the effort to design and make furniture based on the best traditions of the craft, and brought within the present means of production and distribution. It should give unlimited scope for the highest qualities in design and craftsmanship, and would open out fresh channels for the application of those forms of decoration which are allied to it. More carving might be done, and not be so much confined as it now is, to reproductions, or to work other than furniture. The tendency has been to accept certain styles, and to apply them blindly to any and every type of work and position.

The fine art of marquetry has been almost ruined by its bad design and application to miscalled cheap work, as well as by the unfortunate use of stained veneers. In the

natural woods we have an infinite variety of grades in colour—blues and greens only excepted. With the marquetry cutter as a specialist, it is reasonable to suppose that with good designs and colour it should be possible to equal, if not excel, the Dutch or French work.

Closely allied to marquetry is veneering, or the use of finely figured and rare woods in design, as patterns or diapers, or as a covering for plainer wood. The public are inclined to look upon veneering as being done to deceive them. This may be the case in cheap furniture, but it should be clearly understood that good veneering requires more thought and care in preparation and more skill in execution than what is known as solid work, or that which is not veneered. Many of the woods can only be used in this way and their selection needs the utmost care, whilst in no other form can the highly decorative features of the wood be utilised. We have examples of the Dutch and eighteenth century periods to prove that veneered work can stand the test of time. Here and there some good examples are done, but I do not think our designers take as much advantage of this feature as they might. I have some specimens on the table which have been done by young workmen students under skilled instructors, and beyond the actual practice and training in delicate handwork they afford opportunities for the cultivation of harmony in colour, associated with good design—the application of material to method—and what is also essential from a commercial point of view—the power to get the utmost out of it.

On the subject of material, it is unfortunate that we have no Government Department for testing and classifying the new and numerous timbers which are now being sent into the market. However much a maker may wish to use one or more of them, he must do so at his own risk and without any records to prove its fitness. Any red wood is now sold as mahogany, although it may not possess one of its qualities except colour. There are quite a number of colonial woods suitable for furniture. I have a slide showing a furnished room exhibited at the Franco-British Exhibition by the New South Wales Government. The panelling was made of black bean, a rich brown timber, something like teak but better in appearance. A kind of rosewood, and silky oak—which is prettily figured—were used in making the tables and chairs. The carving was done in white beech, and a carver to whom I gave a sample thought it almost equal to lime. Messrs. George Trollope and Sons, who did the work, speak most highly of all the woods. Africa is also yielding a large quantity of timber, and it would be of the utmost value to the trade if the woods could be tested and classified.

Another neglected feature in decoration I should like to refer to is painting. A great deal is being done in the eighteenth century style on satinwood, and but little—too little—of the delicate Adam's colouring, such as we see on the isolated example—a pier table—at South Kensington. Much of the enamelled work now being made would be vastly improved by the addition of a little colour. For bedroom articles it gives a freshness and daintiness which no other form of decoration can give. Messrs. Heal and Son have recently designed some very successful work of this kind, and there is, I think, room for more. Apart from this purely decorative painting, I believe that the cheaper common furniture would be far better covered with a coat of honest paint than grained, or stained and polished as it is.

I have so far tried to show the possibilities for practical development and betterment, and it may be asked, to what extent are they possible under the present commercial conditions, with a keen competition, division of labour, and the consequent lack of training for the craftsman; to which may also be added the lack of public taste. So far as this last is concerned, I have already mentioned that it must rest with designers to put before the public the best that can be done, in the highest as well as in the commonest work. There is room for the best in all, and I see no reason why the combination of designer and trained workmen, with the machine to serve both, should not produce furniture of good design and within the purchasing power of moderate incomes. The salesman, too, should be perfectly frank with, and gain the confidence of his customer, and assist him to a right selection. It would appear, however, that the greatest power for good rests in the hands of the "buyer," who as a rule is a man of wide experience and exceptional business capacity. He it is who buys stock for the large firms from the actual makers, and it rests with him to accept or refuse the work submitted. If this gentleman were to insist more frequently on better design it would force the makers to employ men who were capable of giving it, and I think his influence alone would go far

in raising the tone of the great bulk of English furniture.

The training of the craftsman has become a national problem. It is admitted on all sides that modern industrial conditions are either too specialised or too strenuous for a lad to get that adequate or sympathetic instruction which should fit him for life as an intelligent and skilled worker. Apprenticeship is ineffective—it exists to a small extent in the furniture trades—but even where it is in operation there is no guarantee of proper training, and boys have to pick up the trade as best they can. The necessity for doing something to take its place has been forced upon the educational authorities. Technical and craft schools have been established to afford instruction in the elementary principles of craftsmanship which the workshops fail to give. I am closely associated with two of these schools, the L.C.C. Shoreditch Technical Institute—situated in the centre of the East-end furniture district—and the L.C.C. Central School of Arts and Crafts in the West-end. In these schools we have classes for young men, who are already engaged in the trade, with instructors who are associated with good firms, either in the studio or the factory. I think everything is done that can be done, through the means of workshop practice, drawing and design, with lectures on materials, methods, and historic periods, to stimulate and guide the efforts of the student. Except for these classes, and the scholarships and South Kensington, there are no special means of encouragement to young designers or craftsmen to study historic art applied to furniture. If the authorities could be induced to offer travelling scholarships to some of our promising students, they would, I am sure, be of material and direct assistance in the development of good design and craftsmanship.

Apart from the classes for evening students, we have at Shoreditch a Day Trade School for boys who are about to enter the furniture and woodworking trades. They come straight from the elementary school and go through a two or three years' training in the principles underlying art and craft work. Their general education is continued and applied in as practical a manner as possible. As the first school of its kind, we believe it has gone a long way towards filling the gap which the decay of apprenticeship has made. The instructors are men with a business experience and an art or craft training, and we hope and believe that boys who go through the school are imbued with some ambition to strive and excel. We realise that such a school has its limits, that it cannot give a boy that measure of experience which can only come to him outside, when he enters a stern competitive system and has to earn his living in it. But we do profess to give him a good start, to train the germs of initiative so that he can take his place as an intelligent starter, with a sound knowledge of what he must meet and overcome. But how small and insignificant even this effort is compared with the enormous number of boys who take up craft work with but little hope of any training!

The position and existence of the furniture industry must depend upon the intelligence resource, and skill of its workers, whether a the desk or the bench. It is to the advantag of all concerned in it, as well as to the genera good, that English designers and Englis furniture should command the admiration c furniture buyers in all countries, as well a the approval of those at home. I am con vinced that if we foster its great traditions- bring into active influence some of the force I have mentioned, and train the craftsman- it will not only gain that approval, bı continue to hold it.

I have selected my slides to show as far a possible the types of which I have spoken, an am indebted to the following gentlemen f the loan of photographs from which the slid have been made:—Mr. Charles Allom, White, Allom, and Co.; Mr. Ambrose Hea of Heal and Son, Ltd.; Messrs. Waring an Gillow, Morris and Company, Geo. Trollope a Sons, Mr. J. S. Henry, Mr. Charles Spoone Mr. B. T. Batsford, and Mr. Hamilton T. Smit

If time had permitted it would have be easy to treble the number of examples. Tho I have shown are representative of the be thought and the finest work. We may fe satisfied that such work is being done in o English workshops. Against it we have put the enormous quantity of middle-cla furniture which is commonplace, and the st larger quantity of the cheaper class which nasty. Even this has to be designed by som body; and, in addition to any suggestions have been able to make, the greatest measu of improvement all round can only come wi a change in the general attitude of mind when it is realised that ugliness is brutalisı and beauty is uplifting. Then, and then onl shall we have the great mass of Engli furniture what it has been in the past—go to make and pleasant to live with.

DISCUSSION.

The CHAIRMAN (Sir George Birdwood) said that before inviting discussion he felt it his duty to offer a few remarks of his own. In the first place he desired to express the extreme pleasure with which he had listened to Mr. Wells's paper, and to say that for his own part he entirely concurred with the views therein expressed. If there was anything he had to say in the way of criticism it was with regard to the slides which had been thrown on the screen, which he thought showed that there was a little over-decoration in English furniture. Speaking personally, he was very simple in his tastes, both with regard to furniture and all kinds of ornamentation. His education had been chiefly in the East, due to his long observation of life in India, and the great principle he had adduced from his experience there with regard to furniture was to do without it as far as possible. The only bed known to the Indian was the carpet upon which he lay and stretched himself at night; chairs and tables he had none, for he sat upon the ground. In a tropical climate one should do with as little furniture as possible, indeed, he would go further and say with as little clothing as possible. But here our furniture was overdone, and our dress was overdone. Further, he desired to say that he felt greater confidence in the taste and skill of the British workman than Mr. Wells apparently did. Ever since the great Exhibition of 1851 he had taken what he hoped was not only an intelligent, but a patriotic, interest in the development of taste in England. It was well known that in Tudor and Queen Anne times, and in the Chippendale and Sheraton period, we led the taste of Europe with regard to furniture, and we were quite as capable of doing that now as then; in fact, we *were* doing it. He considered that England at this moment was ahead of any nation in the world in several branches of decorative and semi-decorative art. No nation could approach us in saddlery, and no nation could approach us so far as men's dress was concerned, though he must admit that we were very backward in the matter of women's dress; while no nation could approach us in the art of furnishing. Mr. Wells had mentioned the fact that the present German Emperor had had his yacht furnished by a London firm, but perhaps it was not so well known that the late German Empress had had the whole of her house furnished from London. There was at the present time a perfect rage for English furniture in France, and our leading cabinet makers supplied unlimited quantities of furniture to the Continent. The same remark applied to pottery. No nation made better china or earthenware than we did at this moment. The only thing in which we were backward with regard to decorative art was jewellery; but we were coming forward in that. In jewellery, ornamentation was everything; but with regard to chairs and tables, it was of prime importance that the article should be useful, and ornamentation must be entirely subordinate. It was noticeable that every form of jewellery shown at the exhibition last year very closely approached the best workmanship of France, and certainly excelled that of Germany. On that account he had unlimited faith in the British workman, and the reason for the apparent decline in public taste was because he did not get sufficient encouragement; but whether it was due to Free Trade or Protection he did not pretend to say. He had been brought up under Free Trade, and he had seen this country made a great Empire by it. It was an undoubted fact that we should never have been allowed to hold Egypt or to extend our Empire in India had we not thrown our conquests open to the whole world. With regard to Free Trade injuring the general trade of the country, diminishing employment, and being injurious to taste he could not say. Personally he was a strong trade unionist, belonging, as he did, to the medical profession, which was one of the strongest trade union organisations; but he was inclined to believe that unionism in this country had affected the efficiency of the workman. It was distinctly a wrong thing that a workman absorbed in his task of tooling a book, or whatever it might be, should be compelled to throw down his tools when the clock struck, and run the risk of a reprimand if he continued to work after a specified hour.

Mr. S. HICKS (Principal of the London County Council Shoreditch Technical Institute) said that though he could not criticise the paper from the point of view of construction, he was keenly alive to the need that the boys in the schools should be versed in the very best examples which could be put before them. Good workmanship generally meant good manhood, and boys who were taught to work well generally became good citizens. He had been very much struck with the lucidity of the author of the paper, and desired to express not only the pleasure he had derived from listening to the paper, but the gratification he experienced at Mr. Wells's reception, inasmuch as he was in daily association with that gentleman.

Mr. H. BATSFORD also desired to thank Mr. Wells for his most interesting paper, and for the very fine slides he had put upon the screen, showing what good work was now being produced in this country. He thought the Society of Arts ought to be very much congratulated in getting a man like Mr. Wells, who knew thoroughly the practical part of his craft, to come and lecture before them.

Mr. C. ALLOM thought that the most important point which English designers had to study and work up to was that of proportion, a quality which had existed in the past, particularly from about 1650 to

1800, but which had largely died out in the present day. He could not help feeling that the sense of proportion was to a very great extent inborn, so much so, in fact, that designers should be reared and live amongst beautiful things. The habit of seeing and living with beautiful things led eventually to the ability of distinguishing between that which was beautiful and that which was not. Mr. Wells's observations on the lack of decoration called, he thought, for some remarks. In the first place the Royal Academy and the painting schools had done so little for decorative art that he could only describe it as a scandal. At the present time painters were lacking work; men had had to drop picture painting for portrait painting, and decorators knew only too well the horrors that were so frequently seen on the walls of the houses. As a decorator he often suffered anguish when he knew that a portrait was going into a room which he had to decorate. He did not wish to praise modern work too highly, but it grieved him to see the appetite which the wealthy people of this and other countries had for purchasing old pictures. The desire seemed to be to buy old pictures, the idea being that as a rule they had more tone and harmony; and having those qualities they became more beautiful to live with. He was sorry to say that too frequently the portraits which he saw in houses lacked decorative quality. He was afraid they were usually painted to have force and to attain great notoriety in the Academy, having in the background an environment which was distinctly calling for force, and perhaps too great force to permit their properly decorating the room. He should like to see the Royal Academy giving more of its attention to decorative painting. Very few men could paint such pictures as hung on the walls of the room in which they were that evening, and he hoped that men like Professor Moira and others would set their influence at work and produce more decorative painting in England. A great deal depended upon patronage. In this country there was no patronage, because there was not the wealth or spending power in luxuries which some other countries possessed, notably the United States. The Chairman had referred to a desire to see very little furniture, and very little clothing. He (the speaker) was disposed to think—he hoped the meeting would forgive him for referring to a political subject, but the Chairman had done so—that if things went on as at present, there would be very little left for furniture or for clothing. Mr. Wells had referred to the salesman's and the buyer's influence, and in that he was perfectly right. If a salesman had not a high ideal it followed that he could not inspire his client with a high ideal. If the salesman had no high ideal he would allow his designers to fall behind. The author had stated that a great load lay upon the salesman and a tremendous load upon the buyer; though he (the speaker) thought more rested upon the designer than upon either. The designer could check a poor salesman, but the poor salesman led the customer astray. One could not have failed to notice the influence of the machine in the examples Mr. Wells exhibited, and it was an influence to which attention might well be drawn. In the old days mouldings were run by hand, and a certain free-hand beauty resulted from the fact that none of the mouldings were geometrically accurate. The work to-day was largely spoiled by the fact that the machine rendered each moulding absolutely true from beginning to end. It had often been said that modelled work had no character. He believed that was largely due to the fact that there were so many books. There were more facilities for travelling and seeing things at the present day than existed years ago, and it was very difficult for designers' development to be along one line as it used to be in the old days. In the days when books were difficult to obtain and photographs did not exist one could hardly fail to develop what was in one's nature; but in these days one had to develop a thing, whether one liked it or not.

The CHAIRMAN said it only remained to him to propose a vote of thanks to Mr. Wells for his admirable paper. He congratulated him first upon the paper itself, and, secondly, on the reception he had received from the large audience which had gathered together to welcome him.

The vote of thanks was carried unanimously.

Mr. WELLS, in reply, said he was delighted that the Chairman and the speakers generally had practically endorsed the views he had expressed in his paper. He agreed within limits with Sir George Birdwood's remarks on the question of simple furniture, and also with what he had said with regard to the English designer. He (Mr. Wells) was proud of the work he had shown, both the cottage furniture and the finer and more ornate examples; and he was extremely anxious that we should be able to continue to hold our own in the future. But there were signs that if something were not done in the direction he had tried to point out, we might not continue to do so. Sir George Birdwood had referred to the influence of trades unions. He should have preferred someone actually connected with the trade to answer the question, but speaking for himself he felt that trades unions were not doing what they might with regard to the training of young apprentices and craftsmen. They were not, he thought, giving sufficient support to the keeping up of the standard of work, but they were giving rather too much attention to the standard of wage. While admitting that from the trade unions' point of view that was necessary, on the other hand he believed that they would be more powerful and do a greater amount of good if they took a wider view of craftsmanship, and gave every possible encouragement to their fellow workmen, and

especially to the younger members of the unions, and so inspired them with the spirit of fine craftsmanship which was so well illustrated in the work and influence of the old guilds, but which the modern trade unionists had entirely lost. He was glad that Mr. Allom, to whom he was much indebted for assistance in the preparation of his paper, agreed with him on the essential points, that the buyer and the salesman and the designer could do more than they did at present. With regard to mouldings, however careful designers might have been in the matter of proportion and details, it frequently happened that the mouldings were spoiled by the men at the mill, for they did not appreciate good form. In conclusion, he desired to thank his audience for the manner in which they had received his paper, and especially Sir George Birdwood for his kindness in taking the chair that evening.

THE GREAT WALL OF CHINA.

Dr. W. E. Geil, author of "A Yankee on the Yangtze," has just returned to his home in Pennsylvania, after a twelvemonth spent in exploring the Great Wall of China from end to end. Although numerous travellers have crossed the periphery of this great structure at various points between the shore of the Gulf of Pe-chi-li, at Shan-hai-kwan, and the deserts in the north-west of Kansu, no previous explorer had ever apparently conceived the notion of following the alignment of the wall and thus forming an accurate and comprehensive notion of its character as a whole. Dr. Geil is now busily engaged in working up his materials, not the least important part of which is a rich collection of photographs, which will illustrate long sections of the wall in localities never before visited by Europeans. In the southern part of the province of Honan the doctor claims to have discovered some remarkable aborigines in the shape of wild men, as well as a race of dwarfs, both these tribes having been driven by the encroachment of the Chinese into inaccessible mountainous tracts. The chief authority on the Great Wall of China, from a historical and scientific point of view, is undoubtedly Dr. O. F. von Möllendorf, formerly of the German Consular Service in China, who, as well as his brother, personally examined several parts of the wall, mostly within a few days' journey of Pekin, and studied very exhaustively all European and Chinese references to the subject, from the earliest records down to those of 1880. Dr. von Möllendorf's treatise is in the "Zeitscript der Deutschen Morgenländischen Gesellschaft, 1881," vol. 35. One of its main conclusions establishes the important point that the Great Wall exhibits and consists of at least four strikingly different styles of construction, and that it is a great mistake to speak of it as a homogeneous structure, dating throughout from great antiquity. The most important section would appear to be that traversing the province of Chih-li, and probably part of Shansi as well, so far as our extremely limited knowledge of the latter country enables one to infer. It consists of a base six yards broad of stone blocks (mostly granite), from which rise two strong walls of large baked bricks or tiles, the intermediate space being filled in with clay, stones, and broken brick-work, and covered or roofed in with bricks. Both sides have low parapets with embrasures, while at irregular intervals rise quadrangular watch-towers. This, the most complete form of the Great Wall, dates from the Ming dynasty (1368-1644), while the other forms are less important and essentially different, and occur in Shansi, Shensi and Kansu. As we know, Dr. Stein found traces of the Wall as far west as Ansichow, while Dr. Geil claims to have discovered a hitherto unknown section to the immediate west of Sining-fu, an identification which finds curious corroboration in a passage in Gouebes's narrative of his travels (*vide* "Astley's Voyages"), where he speaks of the citizens being accustomed to promenade along this Wall as far Su-chow, to the north. There it no doubt that Dr. Geil's work, when published, will shed much useful historical and geographical light on this extraordinary structure which in its various forms has played a very prominent part in the annals of the Chinese Empire.

DEW-PONDS.

Since the reading of the paper on "Dew-ponds," by Mr. George Hubbard, on the 3rd of March last, a good deal of attention has been drawn to the subject. "E. A. M." has contributed an article to "Nature," of the 22nd of April, in which he somewhat controverts the view of Mr. Hubbard that such ponds depend on their water supply from dew, or rather from the condensation of aqueous vapour in the air.

Referring to the well-known method of obtaining ice in India by placing pans of water in shallow beds filled with straw, the writer remarks:—

"This is excellent so far as it goes, and Dr. Wells records that he performed the same experiment in England nearly a hundred years ago. Thus there is a presumption that if straw be laid down under a pond, it may act in such a way as to cut off the heat of the earth below. The difficulty lies in carrying out a similar process on a large scale, and at the same time in keeping the straw dry. Should it become moist, and it must do so if in contact with puddled clay, it will cease to be an efficient non-conductor of heat, and it must be borne in mind that whereas the straw under the ice-pans in India can be, and is, frequently changed, this cannot be done under a pond. Mr. Hubbard says: "In numerous dew-ponds in this country the dew-point is reached without difficulty." Nothing is given in support of this statement, and we may well ask on what evidence it is

based. It presumably means that the water itself reaches a temperature which is below the dew-point. A number of observations made by the writer have never yet revealed the fact. The water of a pond parts with its heat extremely slowly. To be of value toward the replenishment of a pond, the dew must be received in the height of summer, when there is but little rainfall, and when, as is admitted, the ponds at lower levels are drying up. The pond is heated during the day, and evidence is wanting as yet that it falls below dew-point at night. Of course, dew is being received on the grassy banks around, that is to say, on vegetation, but the radiating powers of water and grass are apart as the poles, and on radiation dew-fall, as we know it, depends.

"As Mr. Hubbard states, the altitude of the ponds may result in some amount of condensation, owing to the lowering of temperature resulting from the expansion of the air. This would, however, be but a small factor, whilst the condensation would show itself as mist. There may be something, too, but not much, in the osmotic action of dew-pond water, containing as it does a small proportion of sodium chloride. But there must be some greater factor at work if we are to credit the few records which have been made of the acquisition of, for instance, '3½ inches of water after five nights of heavy dew.'

"Mr. Hubbard rightly judges the importance of the dew-pond principle, if fully established, in countries where there is no natural water supply other than dew. He is also quite correct in dwelling upon the importance of vegetation in increasing the rainfall of a district. But when we hear of the rising of the water in a pond by an inch or more in a night, we desire to know if there are any overhanging trees, and whether there are grasses rooted in the bottom of the pond, with several inches of their growth exposed to the atmosphere. The dew deposited on these would be a large item, and would go to feed the pond. Still, there are undoubtedly some ponds, of large size, with no vegetation appearing above the surface, no drainage except from their own shelving bank, the only visible means of recruiting of which consists of rain and driving mists. Given a period of drought, yet these ponds seem to suffer but little. I am not at all satisfied that straw is really a necessity of the case. I have collected information from several different quarters as to the manner of construction of dew-ponds, but straw is not used in all cases, and when used it is frequently placed above the clay merely to prevent cattle from tramping through the bottom and so allowing the water to escape. If dew-point is reached in the air above a pond, there must be some other factor than the alleged chilling of the clay or the water to bring it about. There is room for more experiment."

There has also been some correspondence in *The Field* on the same subject. This commenced with a letter in *The Field* of March 20th from Mr. Arthur Beckett, in which was given some very interesting information as to the method of making dew-ponds, collected by Mr. Beckett, and supplied to him by Mr. Pickard, the steward of the Glynde estate, near Lewes. According to Mr. Pickard's information, these ponds were constructed of Portland cement and sand, or of mortar into which flints were rammed. Full details are given by Mr. Beckett of the whole process of construction. The ponds in question are not filled by surface water, and he says:—

"During the past few months I have been in correspondence with several scientific students, who have made the thermo-dynamics and hydrostatics of dew-ponds a special study, and have talked with men who have had practical experience of the making of dew-ponds, which they have in many instances kept under close personal observation for long periods. After listening to the many arguments adduced on both sides, and keeping an open mind on the subject, I have been forced to the conclusion that the dew-pond of the downs depends for its water chiefly upon rains, and, in a much smaller degree, on mists and hill fogs, and that dew, *per se*, forms a very inconsiderable factor in the supply."

This view was controverted by a writer signing himself "East Sussex," who described a method of making the ponds out of ground-up and rammed chalk, which set into a hard mass like cement, and was impervious to water. The argument was put forward that the position of these ponds on the top of hills precluded any other source of supply than dew and mist.

Mr. Beckett continued the correspondence in *The Field* of the 24th of April, in which he reiterated the opinion that though hill-top ponds were partly supplied from rain, mists and fog, by far the greater part of the water was supplied by rainfall.

ARTS AND CRAFTS.

Arts and Crafts at the New Gallery.—The greater part of the craft work at the New Gallery this year takes its place, along with the sculpture, in the Central Hall instead of being relegated to the comparative obscurity of the Balcony. This arrangement not only allows the larger works to be seen to better advantage, but proclaims to the casual visitor who is usually thinking of nothing but pictures, that the exhibition is partly devoted to handicrafts. And it must be admitted that the collection as a whole quite justifies its place. The illuminations of Mr. Allan Vigers, if rather coarser than we expect to find in work of this description, are full of vigour and form most satisfactory enrichment to the well printed pages which they adorn; whilst Mr. Howson Taylor, amongst his collection of pots, shows some very interesting examples of crackle. Many well-known metalworkers and jewellers, too, send examples of their work:—Mr. Harold Stabler is represented by a large altar cross and candlesticks as well as a fi

silver and enamel centre piece for the 5th Battalion of the Welsh Regiment; Mr. Paul Cooper has a case of silver work; Mr. Nelson Dawson sends quite a quantity of silver, copper and enamel work, and Mr. and Mrs. Gaskin show a charming little selection of jewellery. Mr. James Cromar Watt exhibits amongst other things a piece of opaque enamelwork which is a wonderful imitation of old Chinese colouring, and a pendant in translucent enamel, portraying a polar bear in arctic surroundings after the design of Mr. John M. Swan. There are a few exhibits in the Balcony. The case of enamelled glass by Miss Nella Casella is well worth looking at, whilst the books bound by Miss Catharine Adams, who has had the happy idea of making dainty little covers for some of the smaller volumes, are admirable examples of bookbinding. Altogether the work on view at the New Gallery forms a show which is very fairly representative of the best that is being done in certain branches of the artistic crafts.

The Building Trades Exhibition.—For anyone who approached it from the point of view of art and craftsmanship the Building Trades Exhibition at Olympia proved rather a bewildering affair. To begin with, the work with some claim to be artistic had to be picked out from amongst a mass of exhibits purely and frankly utilitarian, and again, whilst in some trades the best manufacturers thought it worth their while to exhibit, in others they left the field free to the second class firms, and in yet others many of the foremost makers were content to let their products appear as subsidiary to the exhibits of other trades. Some of the most prominent tile-makers, for example, were only represented by work which occurred in conjunction with fireplaces shown by the various grate makers. For all that, the exhibition had a value as showing not so much the best that can be done in the well-founded and established industries connected with the building trades, but the ways in which various materials are being for the moment most generally employed, and what can so far be done in the newer articles and processes which are coming to the fore.

The various kinds of enamels and paints, washable and otherwise, were somewhat less in evidence than they were two year sago, and there was, perhaps, rather less space devoted to wallpapers and other wall coverings of a similar nature, but of tiling there was a really large show. Messrs. Doulton's stand was mainly noticeable for the sanitary ware, and the exhibit of Messrs. Minton and Co., though it included up-to-date work, was not peculiarly remarkable, whilst the leadless glaze tiles of Messrs. Carter, of Poole, though, in a way, very well worth looking at, did not offer to the unbiassed observer convincing proof of the superfluity of lead as a factor in pottery production. For all that, there was some interesting tiling shown. The surrounds of many of the fireplaces, scattered about the exhibition, contained some really admirable tile designs, and it is satisfactory to note that the regulation set slabs for the sides of fireplaces are not apparently in such high favour as they were some years ago. Side panels want planning, but they do not gain by being treated always too closely on the same lines. Some of the wall tiling, notably that exhibited by the Art Pavements and Decorations, Limited, executed in "Medmenham" tiles from designs by Mr. Conrad Dressler, showed what happy effects can be got from quite simple tiles when their disposition on the wall has been skilfully and tastefully thought out. By the way, most of the most successful wall-tiling schemes seem at present to be carried out in "raised line" tiles. Of glass tiles there was again a large display. The quality of the surface is somehow always rather unpleasing, and the more ambitious efforts in the way of ornament do not seem to have been crowned with success, but some of the dadoes made up of marbled tiles bordered by a simple band of ornament are quite good of their kind. The new mosaic rubber tiling of the India Rubber, Gutta Percha, and Telegraph Works Co., Ltd., was well worth looking at. Rubber tiles, of course, are very pleasant to walk upon, and in this case, as the colours extend throughout the whole thickness of the rubber, the permanence of the designs is assured. The big lily pattern pavement was hardly the happiest thing to attempt in this kind of material, but the tiles lend themselves admirably to simple, rather geometric, designs, and some of the colourings, especially the mottled greens, &c., are very pleasing. This form of floor covering seems, so far, to be rather expensive, but for many purposes it should be not only very useful, but quite as beautiful as its position demands.

The School of Art Wood-carving.—The recently issued report of the year's work at the School of Art Wood-carving affords pleasant reading. There are numerous craft schools and trade schools scattered over greater London, in which many or few crafts are taught according to the needs of the neighbourhood or the conditions of the industries, but a school where both professionals and amateurs can be thoroughly instructed in one craft, and in one craft only, is somewhat of a rarity. Schools, whether owing to the attitude of the teachers or the action of the trade unions, have a way of being filled too exclusively with trade or with amateur pupils as the case may be, to the detriment of both types of students. There is always a danger of trade students getting "trady" and of amateurs being serenely unpractical, and when the two classes work side by side they inevitably and unconsciously rub off some of each other's sharpest corners.

That 53 of last year's students were "trade carvers, professional teachers, or students learning the trade professionally" is a proof of the thorough nature of the teaching given in the school. Again, the fact that during the year the pupils have had the opportunity of trying their hand at work of so practical a nature and on so large a scale as is implied by exe-

cuting or helping to execute orders for, amongst other things, "a staircase, two door cases and a chimney piece" proves that the scholarship boys sent by the London, the West Ham, and the Kent County Councils are getting a training which will more or less take the place of apprenticeship and fit them to be really useful in a workshop when their three years at the school are finished.

The opening for women students seems to be rather in the direction of teaching—and a number of old pupils are at present holding posts in schools or under County Councils in places as widely distant as Kent and Yorkshire.

The quality of the work cannot of course be demonstrated in a report, but the fact that the school's exhibit at the Franco-British Exhibition gained a diploma of honour and was by special request sent out to be exhibited at Buda Pest, speaks for itself; whilst the few pieces of work included in the recent London County Council exhibition at Whitechapel were undoubtedly far and away ahead of any other wood-carving to be seen there. It is to be hoped that in its new home in Thurloe-place the school has before it a career of still greater usefulness than in the less convenient premises in Exhibition - road which it occupied until last Christmas.

The Turnery Exhibition at the Mansion House.—There was a good deal of interesting work to be seen at the Mansion House a few days ago, when the objects entered for the 32nd prize competition promoted by the Turners' Company were on view there. Prizes were awarded to trade competitors for work both in wood and pottery, and a fair number of amateurs competed for the certificates offered in their section. While in most crafts the amateur is, as a rule, far below the level of the trade worker, in turnery his work is distinguished from that done for the trade rather by its extra delicacy and smallness of scale, and by the employment of such relatively costly materials as ivory and tortoiseshell, and the happy combination of various hard woods, than by any lack of technical achievement. Amateur work in this particular instance is, in fact, what its name implies—the work of those who love what they are doing and have leisure to bring it to perfection.' Thus it is not surprising that much of the amateur work shown attained a very high standard of workmanship. It is satisfactory to note that in the various trade classes the prizes seem to have been awarded rather to good - turned shapes well carried out than to more ambitious work which is often far less tasteful and less thoroughly suitable to its purpose. The set of furniture legs included in the work which took one of the highest awards was specially commendable for taste and restraint. Turning is, of course, looked down upon by many artistic folk as a "mechanical" process. But those concerned with the improvement of industrial art would probably do better if they took up a more sympathetic attitude towards it, in view of the fact that many things must inevitably be turned. The exhibition at the Mansion House certainly showed that the trade itself is actively trying to encourage what is best both in design and workmanship.

QUESTIONS AND ANSWERS.

NOTICES TO CORRESPONDENTS.

Readers in search of information which cannot be obtained from the usual sources are invited to make their wants known in the *Journal*, in the hope that they may be assisted in their difficulties by their fellow members.

On all communications must be written the name and address of the sender, not necessarily for publication, but as a guarantee of good faith.

Each question or reply should be written on a separate sheet of paper, and should bear such signature of the writer and such address as he wishes to appear.

Questions which can be answered from the usual books of reference, will not be printed.

QUESTIONS.

STATIC PRESSURE AND COMPRESSION.—Would any reader say what additional pressure per square inch is added to any given depth of water at the bottom of a gas tank when the holder of the gas becomes suspended by the gas it contains?—W. R., Kilmarnock.

CANADIAN AND NEW ZEALAND "WHO'S WHO?"—Are there any books giving information concerning Canadians and New Zealanders similar to that contained in "Who's Who?"—D.

ANSWERS.

FIRE-WALKING IN INDIA.—The following is an extract from the *Pioneer Mail*, of May 25th, 1906:—"Writing about fire-walking, as observed in the worship of village deities in South India, the Bishop of Madras, in the 'Madras Diocesan Magazine,' for May, says:—'A large trench is dug in front of the shrine, about thirty or forty feet long, and ten feet broad, and two or three feet deep. During the morning, this was filled with logs of wood and faggots, which are set on fire, and by the evening become a mass of glowing red-hot embers. After dark, the people assemble with torches, and tom-toms, and music, and then, some thirty or forty people prepare to walk lengthwise over the embers. They are worked up to a great state of excitement by the tom-toms and the shouts of the crowd, and then the whole thirty or forty walk over barefooted, quite slowly and deliberately, in single file, headed by one of the *pujaris*.' This custom of fire-walking is quite common in

Malabar. Kooriche, three miles from Tellichery, in the direction of the French Settlement of Mahe, is a locality reputed for fire-walking. Here a famous *pugari* by the name of Ooochata, dwells. He actually sits on a heap of fire at an annual festival, but is said to be protected by the bark of the areca nut, which is known to be a bad conductor of heat."—W. COLDSTREAM.

FIRE-WALKING IN FIJI.—An interesting article on this subject will be found in *Nature* of December 11th, 1902, where, after a description of the ceremony, the explanation offered by Dr. Robert Fulton is thus summarised:—"The stones took forty-eight hours to get to their 'proper' condition . . . . they were also found to cool very slowly. The same stones are never used twice. They are gradually heated until split by the expansion of the contained water, and are then carefully arranged fractured side upwards. The stone that was examined was an augite-andesite of ordinary type. Prof. Park, of the Otago School of Mines, found that, taking the thermal conductivity of copper as equal to 1,000, that of andesite is 6·67, that is, it is a very feeble conductor of heat. . . . . Thus the fractured, or inside, surface of the stone, owing to its slow conductivity, does not receive nearly the amount of heat one would expect, and, owing to the slow radiation of heat, the foot is not burnt when coming into contact with the stone for a second or less; as a matter of fact the sole of the foot was at no time in contact with a hot stone for more than half a second."—H. G.

NOTES ON BOOKS.

PIONEERING. By Frederic Shelford, B.Sc., M.Inst.C.E. London: E. and F. N. Spon. 3s. net.

This useful little volume consists of four articles which originally appeared in the *Engineer*. They are addressed to "the ever increasing army of young men, such as engineers, surveyors, and public works men, who for the first time are about, for one reason or another, to leave the old country and take up some appointment abroad." Most men in such circumstances are somewhat at a loss to know precisely what sort of outfit it is desirable they should take with them, and many, for want of better advice, are compelled to place themselves in the hands of "outfitters" who frequently furnish them with an elaborate equipment which is as useless as it is expensive. Mr. Shelford, an experienced traveller in many climes, knows what is likely to be essential, what had better be left behind; he deals shortly but effectively with such questions as camp equipment, clothing, fire-arms, medicines, commissariat, and surveying instruments, and he gives some very useful hints on health which should be carefully studied by every young pioneer.

HOMES FOR THE COUNTRY. By R. A. Briggs, F.R.I.B.A. London: B. T. Batsford. 10s. 6d. net.

In issuing the second edition of this work, Mr. Briggs has made considerable additions and effected improvements in the reproduction of some of the illustrations by the "half-tone" process, and the book now contains a series of designs and examples o executed work, with plans of each, illustrated on fifty-four plates. A number of these represent large or moderate sized houses, but there are also many of a less ambitious class suitable for people who are compelled to live in towns, but also desire to keep a small bungalow-house in the country. A few—perhaps too few—words are given in explanation of each plate, and in most cases the approximate cost of the house is stated. Many of the designs are very attractive.

GENERAL NOTES.

COTTON CONCILIATION BOARD.—Representatives of the Federation of Master Cotton Spinners' Associations, and of the Operative Spinners, Cardroom Workers, and Weavers' amalgamations, recently met in Manchester to discuss the proposed framing of a conciliation scheme for the regulation of wages in the cotton-spinning industry. The immediate business of the meeting was to select an independent chairman to preside over future conferences, at which details of the scheme are to be considered. Four names were suggested, and it was agreed unanimously to recommend Sir Edward Clarke, K.C., to the President of the Board of Trade, for appointment; and this appointment has since been confirmed by Mr. Churchill. The choice of a chairman is, of course, only the beginning of a long and complicated task. Much patience and perseverance will be called for before the basis of a conciliation scheme is arranged. The employers and operative spinners are already committed tentatively to an experimental scheme, which has been in operation for a couple of years, but the representatives of the Cardroom Workers Amalgamation are not willing to accept any of the figures of this tentative proposal, without very full reconsideration of the calculations on which they are based. It is earnestly to be hoped that the Conference now sitting will succeed in forming a sliding scale acceptable to all concerned.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

MAY 12.—"The Principles of Heredity as Applied to the Artificial Production of new forms of Plants and Animals." (Aldred Lecture.) By PROFESSOR ARTHUR DENDY, D.Sc., F.R.S., F.L.S.

MAY 19.—"Railway Development in China." By ARTHUR JOHN BARRY, M.Inst.C.E.

Wednesday afternoon, at 4 o'clock:—

MAY 26.—"The Manufacture of Nitrate of Lime from Atmospheric Nitrogen." By SAM EYDE.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

MAY 13.—"Some Phases of Hinduism." By KRISHNA GOBINDA GUPTA (Member of the Council of India). SIR GEORGE BIRDWOOD, K.C.I.E., C.S.I., M.D., LL.D., will preside.

MAY 27.—"The Function of Schools of Art in India." By CECIL L. BURNS, Principal of the Bombay School of Art. PROFESSOR SIR HUBERT VON HERKOMER, C.V.O., D.C.L., R.A., will preside.

COLONIAL SECTION.

Tuesday afternoon, at 4.30 o'clock:—

MAY 18.—"Canada as a Field for British Investment." By J. OBED SMITH, Assistant Superintendent of Emigration, Department of the Interior, Canada. The RT. HON. LORD HINDLIP will preside.

CANTOR LECTURES.

Monday evening, at 8 o'clock:—

F. W. LANCHESTER, "Aerial Flight." Three Lectures.

LECTURE III.—MAY 10.—*The Flying Machine.* —The function and uses of the flying machine—Possible types—The conditions to be fulfilled as defining the type—The need for high velocity—The difficulties of high velocity—The horse-power problem—Motors for flying machines and the conditions governing their weight—Fuels available and the relative importance of fuel economy—Propulsion and the propeller—The use of gearing—The limitations of flight as due to the mode of propulsion—Other modes of propulsion—Wing flapping and its efficiency—Soaring—Starting and alighting—Questions of design and construction—Steering and steering mechanism—Flying at a height—The advantages and disadvantages of altitude—Types of flying machine in practice—The future of flight—The flying machine as a mode of locomotion, in peace and war.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 10...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. F. W. Lanchester, "Aerial Flight." (Lecture III.)

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. A. B. Howes, "Quantity Surveyors: a Review of their Legal Position."

Geographical, Burlington-gardens, W., 8½ p.m. Sir Everard F. Im Thurn, "The Western Pacific."

TUESDAY, MAY 11...Royal Institution, Albemarle-street, W., 3 p.m. (Tyndall Lecture.) Professor S. Arrhenius, "Cosmogonical Questions." (Lecture II.)

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8 p.m. Dr. R. Arthur, "Imperial Emigration and the Problems Connected with it."

WEDNESDAY, MAY 12...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Aldred Lecture.) Professor Arthur Dendy, "The Principles of Heredity as Applied to the Artificial Production of New Forms of Plants and Animals."

Biblical Archæology, 37, Great Russell-street, W.C., 4½ p.m.

Sanitary Institute, 44A, Margaret-street, W. 8 p.m. Discussion on "The Passage of Excreta through House Drains." To be opened by Mr. H. A. Roechling.

Junior Engineers, at Royal United Service Institution, Whitehall, S.W., 7½ p.m. Mr. Thos. S. F. Gibson, "The Construction of Coin Freed Mechanism as applied to Gas Meters."

THURSDAY, MAY 13...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Mr. Krishna Gobinda Gupta, "Some Phases of Hinduism."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Iron and Steel Institute, 25, Great George-street, S.W., 10½ a.m. Annual Meeting.

Royal Institution, Albemarle-street, W., 5 p.m. Mr. J. G. Millais, "Newfoundland." (Lecture I.)

Electrical Engineers (at the HOUSE OF THE ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.), 8 p.m.

FRIDAY, MAY 14...Iron and Steel Institute, 25, Great George-street, S.W., 10½ a.m. Annual Meeting continued.

Royal Institution, Albemarle-street, W., 9 p.m. Prof. G. E. Hale, "Solar Vortices and Magnetic Fields."

Paint and Varnish Society, St. Bride's Institute, Fleet-street, E.C., 8 p.m. Mr. J. Cruickshank-Smith, "The Physics of a Pigment."

Astronomical, Burlington-house, W., 5 p.m.

Malacological, Burlington-house, W., 8 p.m. 1. Lieut.-Col. H. H. Godwin-Austen, "Descriptions of the Animals of Two Land Shells from Perak." (Skeat Expedition in the Malay Peninsula, 1899-1900.) 2. Mr. Edgar A. Smith, "List of Mollusca from Christmas Island, Indian Ocean, and Description of New Species." 3. The Rev. R. Ashington Bullen, "Further Notes on Holocene and Recent Non-Marine Mollusca from Perrangabuloe." 4. Mr. A. S. Kennard, "Non-Marine Mollusca from an Early Neolithic Internment at Cuxton, Kent."

Physical, Imperial College of Science, South Kensington, S.W., 8 p.m. 1. Mr. W. Duddell, "A Bifilar Vibration Galvanometer." 2. Messrs. W. P. Fuller and H. Grace, "Effect of Temperature on the Hysteresis Loss in Iron in a Rotating Field." 3. Messrs. A. Campbell and T. Smith, "A Method of Testing Photographic Shutters."

SATURDAY, MAY 15...Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. Raleigh, "Burke's Prose."

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FRIDAY, MAY 14, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

TUESDAY, MAY 18, 4.30 p.m. (Colonial Section.) J. OBED SMITH, Assistant Superintendent of Emigration, Department of the Interior, Canada, "Canada as a Field for British Investment."

WEDNESDAY, MAY 19, 8 p.m. (Ordinary Meeting.) ARTHUR JOHN BARRY, M.Inst.C.E., "Railway Development in China."

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

On Monday evening, May 10th, Mr. F. W. LANCHESTER delivered the third and last lecture of his course on "Aerial Flight."

On the motion of the CHAIRMAN (Professor C. V. Boys, F.R.S.), a vote of thanks to the lecturer was unanimously passed.

The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION.

On Thursday afternoon, May 13th, Mr. KRISHNA GOBINDA GUPTA (Member of the Council of India), read a paper on "Some Phases of Hinduism." SIR GEORGE BIRDWOOD, K.C.I.E., C.S.I., M.D., LL.D., presided.

The paper and discussion will be published in a subsequent number of the *Journal*.

NORTH LONDON EXHIBITION TRUST.

In 1865 the Committee of the North London Working-classes and Industrial Exhibition (1864), presented to the Society of Arts a sum of £157, the balance of the surplus from that Exhibition, with a view to the annual award of prizes for the best specimens of skilled workmanship exhibited at the Art Workmanship Competitions of the Society of Arts. The Art Workmanship Competitions were discontinued after 1870, but since that date various prizes have been awarded under this Trust. Prizes were offered to the students of the Artistic Crafts Department of the Northampton Institute, Clerkenwell, in 1903, and have been continued annually to the present time. These have been awarded, for the present year, as follows:—

First Prize, value £3, to John Allan, for a model design for a memorial.

Second Prize, value £2, to W. W. Meedy, for drawings and examples of copper-plate and mezzotint engravings.

CONVERSAZIONE.

The Society's Conversazione this year will take place at the Natural History Museum, Cromwell-road, S.W. (by permission of the Trustees of the British Museum), on Tuesday, June 29th, from 9 p.m. to 12.

The programme of the arrangements will be announced in a future number of the *Journal*.

CANTOR LECTURES ON CLOCKMAKING.

The Cantor Lectures on "The Theory and Practice of Clockmaking," by SIR HENRY HARDINGE CUNYNGHAME, K.C.B., have been reprinted from the *Journal*, and the pamphlet (price two shillings) can be obtained on application to the Secretary, Royal Society of Arts, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

Thursday afternoon, April 29; The RIGHT HON. VISCOUNT MIDLETON, late Secretary of State for India, in the chair.

The CHAIRMAN, in introducing the reader of the paper, said that Mr. Fremantle's credentials for giving the paper were that he had been for nearly twenty years a member of the Indian Civil Service, having filled a number of posts in different districts of the United Provinces. In 1905 he was placed on special duty with regard to the question of labour supply in the United Provinces and Bengal: in 1906 he was charged with some important investigations with respect to Co-operative Credit Societies in the United Provinces; and he was at the present time taking part in the enquiry being held in England, under Lord Sanderson's presidency, with reference to the emigration of Indian coolies to Crown colonies. When he (the Chairman) asked the author to jot down for him the appointments which he had filled, Mr. Fremantle modestly prefaced the list by saying that his career had been a very humdrum one. Mr. Fremantle's attitude was characteristic of a service second to none in the world for ability, assiduity, and succe s.

The paper read was:—

THE PR)BLEM OF INDIAN LABOUR SUPPLY.

By SELWYN HOWE FREMANTLE, I.C.S.

While the question of unemployment occupies so largely the attention of the Western world and many economists almost despair of its solution, it may be refreshing to turn for a time to the Indian continent, where in normal seasons there is work for everyone, and, indeed, constant complaints arise of the difficulty of securing a regular and efficient supply of labour. The fact is surprising enough in view of the density of the population. The average density for the whole continent is 167 to the square mile, and in British India 213.

DISTRIBUTION OF THE POPULATION.

The "Imperial Gazetteer" has an instructive passage on the distribution of the population which I quote here:—

"The greatest density of population is found in the great Gangetic plain, and the next greatest in the narrow fringe of alluvium which lies between the sea and the elevated interior of the Peninsula. As a general rule it may be said that high or low density is concomitant with large or deficient rainfall; but there are of course other factors to be reckoned with. In the western portion of the Gangetic plain the rainfall is not large; but the want is supplied by artificial irrigation from a network of canals, and the land thus supports many more inhabitants than it could otherwise find food for. Much also depends on the character and configuration of the surface, as in the uplands of Chota Nagpur, where there are extensive areas quite unfit for cultivation, and the population is thus very sparse in spite of a fairly copious rainfall. The influence of climate is also well marked, and the malarious "tarai" which stretches along the foot of the Himâlayas possesses far fewer inhabitants than might be expected from its rainfall. Lastly, there are variations due to historical causes, as in Burma, which has but recently enjoyed a settled and civilised government, and which, though half as large again as Bengal and favoured with a good and regular supply of rain, possesses less than one-seventh the population of that Province."

Thus it would seem that except in Burma the population is as great as under existing conditions the country can afford to support. And the population tends to increase *pari passu* with agricultural and industrial development. In the decennial period 1881 to 1891 the increase under favourable circumstances was 9·8 per cent., and even in the period 1891 to 1901, which was remarkable for two great famines and for a severe epidemic of plague, there was a growth of 1·5 per cent. It is true that of the large population nearly two-thirds occupy only a quarter of the area of the whole country, but this is just the tract in which industrial enterprise is most active and complaints of scarcity of labour most frequent. In certain districts, indeed, the density is acute. Thus Dacca, in Eastern Bengal, for purely country districts, takes the lead with a population numbering 952 to the square mile, and the Behar districts of Muzaffarpur and Saran support a population of 917 and 907 to the square mile respectively. These districts are within 400 miles of the busy hives of industry on the banks of the Hooghly, and their surplus population is available to supplement that of Calcutta, which, with Howrah, numbers over 1,100,000 souls. In the United Provinces 36 districts out of 48 have a density exceeding 400 to the square mile, and there are five considerable cities with an average population of 206,000 each. Bombay city had in 1901 a population of three-quarters of a million, and, though the density of its neighbouring districts cannot be compared with that of the Gangetic

valley, the fertile strip along the coast to the south and the plains of Gujerat to the north are well-peopled according to ordinary standards.

Scarcity of Labour in Organised Industries.

All the densely populated districts mentioned are purely agricultural, and they are situated within easy reach of the manufacturing centres. How comes it then that difficulty is experienced by employers in attracting labour to manufacturing and other industrial concerns? The Conference of the Indian and Ceylon Chambers of Commerce on January 6th, 1905, passed a resolution in the following terms:—

"Whereas the supply of rank and file labour for organised industries is inadequate in many districts of India, and whereas the deficiency is seriously restricting the productive power of a large section of the manufacturing concerns of the country, it seems imperatively necessary to this Conference that in order to devise a remedy measures should be taken by a Government Commission or otherwise to investigate the causes which have led to a state of affairs inconsistent with the relative conditions of life of the factory operative on the one hand and the agricultural classes on the other."

In consequence of this resolution, two officers—Mr. Foley, from Bengal, and myself from the United Provinces—were deputed to report on the question of the supply of labour for mills, mines, factories, and similar industries in Bengal and Upper India, and for the handling of goods in Calcutta and elsewhere. In the course of this inquiry we visited the industrial and commercial centres of Bengal and Upper India, and inspected many factories, mills, mines, jute presses, &c., as well as the docks and jetties on the Hooghly. It is chiefly from the experience gained in this inquiry and from the discussions in which it resulted that the conclusions set forth in this paper were formed.

Jute Mills.

In Calcutta and its neighbourhood jute manufacturing is by far the most important industry. It has developed rapidly in recent years, and on the whole the labour supply has kept pace with the increased demand. In 1895-96 the number of hands employed was 78,000, while now it is more than double that number. Some deficiency is no doubt experienced during the hot weather months, as at this time the up-country men prefer to take their yearly or biennial holiday. This is partly due to the introduction of electric light and longer working hours, which have enabled the workers to earn higher wages and made longer holidays both possible and necessary to them. We could not find, however, that the rates of payment for piece-work had risen to any substantial extent in recent years, or that any attempt had been made by managers to induce their men to take their holiday at different seasons. There is no serious complaint of shortage of labour in this industry.

Cotton Spinning and Weaving.

In Bombay and its neighbourhood cotton takes the place occupied in Calcutta by jute. Of 211,711 persons employed in cotton spinning and weaving 148,753 are in the Bombay Presidency. Bombay Island, with 102,000 workers, is the chief seat of the industry, and Ahmedabad, which employs 25,000 hands, is also an important centre. Of the other provinces, Madras, Bengal, the United and Central Provinces all possess cotton mills employing over 10,000 persons. This industry also has expanded very greatly of recent years. The number of spindles, which was under four millions in 1896-97, now exceeds five and a half millions, and looms have increased during the same period from 37,303 to 59,375. There has been no increase in Bengal or in Madras, which are distant from the best cotton-growing districts. In the other provinces the increase has been gradual and fairly uniform. In Bombay and Ahmedabad there has been no general complaint of scarcity of skilled or unskilled labour of recent years, though there have been temporary difficulties owing to strikes and plague epidemics.

In the United and Central Provinces, however, and in Delhi there have been constant difficulties. These have attracted most public attention in Cawnpore, which is the industrial centre of Upper India. In 1900 a serious plague riot occurred in the town. This led to the imposition of a punitive police tax, and we learn from the report of the Upper India Chamber of Commerce that for some time afterwards the supply of labour was most irregular and unsatisfactory. As Mr. McRobert, President of the Chamber, whom I am glad to see in this hall to-night, observed in 1901, "The mill and factory industries have grown at a faster rate than the city has increased in population, and the employers have entered into keen competition with each other for the labour that is available. The workers have not been slow to take advantage of this state of affairs and show their independence by absenting themselves without leave, breaking their agreements without

scruple, in the full assurance that if dismissed at one factory they will readily find employment next door." In 1902 plague was severe in the town, and the effect on trade was disastrous. The President of the Chamber stated:—"During October, November, and December the supply of labour has been less than half of the requirements, in some cases only a third. Workpeople were seized with panic and left the town, but in January most of them returned. It is almost three years now since the labour difficulty assumed alarming proportions, and the plague epidemic merely accentuated the embarrassment." Again, in 1904, the President dwelt upon the continuance of the labour difficulty. When, however, we visited the mills in the following year it was much less acute, and at the present time it has almost disappeared. Enquiries in Cawnpore and in the cities of Agra, Delhi, Nagpur, and Jubbulpur led me to believe that the serious scarcity experienced between the years 1902 and 1905 was due to temporary causes. Several new mills at Hathras and Mirzapur, in the United Provinces, and at Delhi and Lahore, in the Punjab, had been recently founded, and there had been considerable extensions in the Cawnpore and Agra mills. Each new mill as it started work drew on Cawnpore, the oldest established seat of the industry, for its supply of skilled workers, and gave them inducements to leave Cawnpore. At the same time that city was suffering from recurring epidemics of plague, which caused many deaths among the mill-workers and frightened away many more of them to their country homes. Thus, with an enhanced demand for men and a reduced supply to meet it, it is not surprising that a serious deficiency arose. In course of time the supply has, as was anticipated, adjusted itself to the demand, and during the last three years there has been little ground for complaint. At the same time the position from the point of view of employers is unsatisfactory. Similar conditions may again occur, and if they do occur similar results will follow; for the supply of labour, skilled and unskilled, is wholly inelastic, and if a special and temporary circumstance causes a deficiency, experience shows that it is not possible under present conditions to meet it by special measures of recruitment from outside. The reason for this will be discussed later on.

Cotton Ginning and Pressing.

Steam ginning mills have sprung up of recent years in all the cotton-growing districts, and are most numerous in the uplands of the Central Provinces and Bombay. They employ altogether 94,894 hands, more than double the number of ten years ago. These mills work only for the five months of the cotton picking season, and during two only of these months is the work at high pressure. The labour force, which consists largely of women, is generally left in the hands of contractors, who pay so much per unit of cotton ginned. The earnings are good, and, as the mills are generally clustered in groups of three or four round small towns, there is no difficulty in obtaining labour.

Coal Mining.

Coal mining is another industry which has developed greatly in recent years, and now gives employment to 99,138 persons. In 1897 the number was 59,859, and in 1887 only 28,438. Eighty-eight per cent. of the coal is raised in Bengal, nearly all of it in the three principal coal fields—Raniganj, Jherriah, and Giridih. These tracts are hilly, and somewhat sparsely populated. The pits are, moreover, in close proximity to each other, and must, therefore, be dependent in great part on imported labour, which is difficult to attract and more difficult to retain. The labour question has, therefore, from time to time assumed considerable importance. In 1896 a Labour Enquiry Commission was appointed to consider the best means of supplying labour, and made certain recommendations, the most important being a central recruiting agency to bring men down from the United Provinces and Behar. The various companies, however, found it impossible to combine to support one recruiting agency, so nothing was done. In 1905, Sir E. Cable, speaking on the resolution of the Conference of Chambers of Commerce, said:—"I can confirm the statement that labour is becoming more and more difficult to procure, is insisting on higher wages, and is evincing greater willingness to strike on the slightest provocation." Mr. Foley, who visited the coal fields shortly afterwards, sums up the position as follows:—

"I find that there is no scarcity of labour at Giridih and Palamau; in Jherriah more labour is wanted, and, if it were pointed out how this could be obtained without serious trouble and expense, recruitment to a certain extent would be undertaken, but not otherwise. The same remark applies to the collieries in the Raniganj coal field with certain exceptions. The whole question of labour, however, depends on the question of the market for Bengal coal. If only the market were settled no doubt

more coal could be raised, and managers would find it worth while to recruit more miners. There has, however, been so much variation in the past few years that some uncertainty has prevailed, and the output has in some cases been restricted. At the time of writing the coal trade is prosperous, and there is every expectation that the industry will continue to expand so that more and more labour will be required every year."

In the last three years this expansion has continued, and several companies in their last half-yearly reports have alluded to labour difficulties. In default of the establishment of a free flow of labour between the coal mining and the labour districts, the remedy would appear to lie in the more general use of labour-saving appliances—a matter which will be discussed later.

Transport of Goods.

The growth of railways and seaports has created a very large demand for labour. The number of railway servants has increased in the period 1896 to 1906 from 283,095 to 479,284. During the same time the trade of the seaports has risen from 175 to 283 crores, and this expansion must of course mean that many more unskilled workers are required. There has also been, as a result of trade development, great activity in the building and allied industries in most of the towns and cities of India. Sir Herbert Risley, in his Census Report of 1901, states—

"In spite of the great and growing volume of migration, and of the marked improvement in communications which has taken place in recent years, the complaint is universal that the existing supply of labour is wholly insufficient, and that its growing scarcity and dearness constitute a serious drag on the wheels of industrial progress. At certain seasons an unskilled labourer in Calcutta can earn Re 1 daily, and the ordinary rate is from 8 annas to 10 annas for men and from 5 annas to 6 annas for women. It is said that labour is becoming scarcer every year, and quite recently good unskilled labourers in the Calcutta docks were earning Re 1 8 per day. This rate was of course only paid in a time of special pressure, but it shows how slowly under existing conditions does the supply of labour adapt itself to the demand for it."

Our enquiries in 1905, however, did not lead us to take quite so gloomy a view. The usual wages of permanent hands in Calcutta docks were 10 rupees to 11 rupees monthly, a very reasonable rate; while the daily wage of 8 annas is paid for casual labour. There is abundant labour available throughout the year except in April, May, and June. During these months work is not interrupted for want of labour, but higher rates have frequently to be paid. The deficiency in the hot weather months is due to the large proportion of up-country men employed, who visit their homes at this season.

As regards Bombay, I have not been able to obtain any definite information as to the state of the unskilled labour market. The Administration and Census Reports are silent on the subject. From "Prices and Wages in India" it would seem that the average monthly wage of an unskilled labourer is 11 rupees to 12 rupees, much the same as in Calcutta, and that during the last twenty years there has been hardly any alteration. From this circumstance and from the absence of all reference to the subject in official and other publications, it may be assumed that the supply of labour in Bombay has kept pace fairly well with the demand.

Tea Estates.

The labour force on the tea plantations of Assam numbered on 30th June, 1908, no less than 739,795, of whom 452,464 were adults. This province is the great centre of the tea industry, and, as remarked by Sir H. Risley in his Census Report:—

"The indigenous inhabitants, as is natural where land is plentiful, prefer the independence and ease of a cultivator's life to the regular work and discipline of the tea gardens. The total supply of labour is thus wholly inadequate, and the planters, being forced to seek coolies at a distance, have brought into existence the great recruiting business, of whose attendant abuses so much has been heard of recent years, and the suppression of which was the main object of the Labour Act of 1901."

By this Act recruitment was regulated and abuses checked, but service in Assam continued to be unpopular, and in 1904 a large majority of the proprietors of tea estates in the Surma Valley petitioned that free immigration should be permitted to that valley and the special Labour Acts withdrawn. In 1906 a Committee was appointed to review the whole question, and the result was a report published in the following year. The Committee found that, though the arrangements for the comfort of the labourers and the scale of their tasks were generally satisfactory, the local demand for labour was still largely in excess of the supply owing to the remarkable rise of prosperity among the labouring classes in the chief recruiting grounds and the expansion of mining

and other industries. Certain practical suggestions were, however, made for the improvement of existing conditions, and action was taken in the direction of giving greater freedom to the labourers. At the same time recruitment by unlicensed contractors was abolished, and facilities have been given to recruitment by garden sirdars or headmen working under certain responsible associations. The average wage for a male adult is only Rs.5.13.0 monthly, but a woman can earn almost as much. Free quarters are provided, and an agriculturist very much prefers the work to any form of industrial labour. Special inducements have also been given to settle in Assam by the grant by Government of blocks of lands on favourable terms to tea garden managers for this purpose. The aim of the legislative and administrative measures of recent years has been to make the journey to and from Assam easy and the life there attractive so that labour may flow freely in.

Migration.

Certain large industries such as jute and cotton spinning, mining and tea planting, require a large and concentrated supply of labour. It cannot be obtained locally, nor have the towns any surplus labour for export. It can, therefore, only be supplied from the ranks of agriculturists. Now, the Indian peasant is frequently regarded as an immobile individual, who, whether from ignorance or lack of enterprise, continues to slave in his own home at extracting a precarious livelihood from the soil, while, if he were to travel at most a few hundred miles to one or other of the industrial centres, he would find congenial work at good wages. This view is only true to a very limited extent. It is certainly the case that a peasant needs very considerable inducement to cut himself off entirely from his native village. It is for this reason that there is no considerable settled factory population in any Indian city. On the other hand, the peasant is very willing to go to work, and even to take up permanent employment in a distant place on the understanding that his holidays are spent in, and that he retires ultimately to, his native village, and the Census figures afford very clear indications of his willingness. In Upper India the movement of the population is from West to East, and owing to the development of communications and the spread of education it has been very much more pronounced in recent years.

The following figures show the increase in ten years:—

	Persons born in United Provinces enumerated in 1891.	1901.
Bengal (including E. Bengal)	365,000	497,000
Assam	58,000	109,000
Burma	18,000	34,000

In the case of Bengal the fortuitous movement of population between contiguous districts of the two provinces accounts for about one-fourth of the totals in both years. The remaining three-fourths consist almost entirely of servants and labourers who travelled eastwards in search of work.

The resident of the congested districts in Behar is still more ready to migrate than his fellow in the United Provinces. It is South Behar, Saran, and Muzaffarpur, with a population of 12½ millions, from which labour mostly comes. No less than 475,000 persons born in those districts (or one in 26 of the population) were enumerated in 1901 in Central and Eastern Bengal, and of these 120,000 were found in Calcutta alone.

There is also a large volume of migration from the hilly districts of Bengal (Chhota Nagpur, and the Santhal Parganas) and from the Central Provinces to the mining districts of Bengal and the tea districts of Assam.

For the tea gardens statistics of the nationality of immigrant labourers are given in the annual immigration report. The percentages are as follows:—

	Per cent.
Born in plains of United Provinces and Bengal	36
,, ,, Chhota Nagpur, and Santhal Parganas	38
,, ,, Central Provinces..........	16
,, ,, Madras	5
,, ,, Assam	4

For the coal mines no figures are available to show the proportion of immigrant labourers. The workers in the older Raniganj coalfield are usually from the neighbourhood, Bauris and Santhals. Few, however, live close enough to the pits to return home after their day's work; consequently they visit their homes at frequent intervals, and during the season of rice cultivation are absent for lengthy periods. The newer field of Jherriah is situated in a more sparsely populated district, and the labourers come from greater distances. Some workers are brought in from Bilaspur and the Central Provinces, and some from Rai Bareli and Unao, in Oudh.

In jute mills the proportion of up-country

men is very large. Figures kindly supplied me in 1906 by Mr. Nicoll, President of the Jute Mills Association, for three mills with which he is connected are given below:—

	Per cent.
Residents near the mill	22
Immigrants lodging in bazaar	78

	Per cent.
Of whom born in United Provinces	25
" " Behar	41
" " Orissa	5
" " Other districts of Bengal	7

Bombay city is not so dependent as Calcutta on imported labour, but the Census figures here also show a steadily increasing volume of migration. Thus in 1891 one eleventh of the population enumerated in Bombay city were immigrants; but in 1901 the proportion had risen to one ninth, and the immigrants from the United Provinces increased in the decade from 10,000 to 36,000. Burma is a country which has extensive tracts of good land as yet undeveloped, and a people content with the ample returns from their fertile holdings and disinclined to exertion. With the improvement of communications both in India and Burma a wide and growing outlet is afforded for the surplus population of Upper India and certain tracts of Madras. More than half of the population of Rangoon were born on the Indian continent, and settlements of immigrants from India have been formed in some up-country districts.

The migrant population may be said to be almost entirely agricultural, and the volume of migration (as also that of emigration) is sensibly and quickly affected by the character of the season in the labour districts. Thus the increase of 75,000 in the labour force of Assam during the year 1907-8 is attributed mainly to the famine in the United Provinces, while the scarcity in Southern India in the year 1905 led to an unprecedented increase in emigration to Ceylon. The managers of Bengal collieries find their labour troubles temporarily in abeyance when the rice crop in the surrounding districts has been scanty, while any delay in the establishment of the monsoon in the Behar and Benares divisions fills the neighbouring railway stations with passengers bound for the more fruitful territories to the east.

Emigration.

I can only briefly allude to the interesting subject of emigration from India to the British colonies. Emigration from Southern India to Ceylon began more than a century ago, and at the present time nearly one-third of the population of the island (including the whole labour force on the tea estates) is of Indian origin. This exodus still continues, and during the last five years the number of passengers has exceeded that of return passengers by 110,000. Emigration to the Straits Settlements and to the Malay States is of more recent date, and has been greatly stimulated during the last few years by the development of rubber plantations in the States. The Indian population has increased in five years by over 80,000. Emigration to these two colonies is practically free, labour flowing backward and forward of itself; but for the more distant colonies special recruitment in India and indentures to labour are necessary, and elaborate regulations have had to be made to safeguard these proceedings from abuse. Such emigration began with the abolition of slavery in 1834, and the first shipment of coolies to Mauritius took place in that year. To the West Indies emigration was legalised in 1844, and since that date large numbers of coolies have been shipped to British Guiana, Trinidad, Natal, Fiji, and other places, as well as to Mauritius. To all these places they go under indenture for a term of five years, and a large proportion stay on in the colony as free settlers on the expiry of this term. They have been invaluable in supplying labour for the sugar industry, on which the prosperity of each colony so largely depends. In Mauritius Indians now number 261,136, and form 70 per cent. of the whole population. In British Guiana they number 133,665, or 44 per cent., in Trinidad 103,000, or 30 per cent., in Fiji 28,540, or 22 per cent., and in Natal 112,126. Altogether in British colonies, including Ceylon, there are now nearly two million colonists of Indian nationality. But the average number recruited for the distant colonies each year is now only 16,000, and as on the average 7,000 return, the resulting loss is about 9,000 annually. It is obvious that the abstraction of this small number can have no appreciable effect either on the congestion of population in the crowded districts or on the general labour market.

Recruitment.

The only organised labour recruitment in India is that undertaken for the Colonies (including the Straits Settlements) and for Assam. To the jute mills and Calcutta generally there is a free flow of labour from the

United Provinces and Behar. For certain seasonal occupations, however, such as jute-pressing and brick-making, agents are sent at the proper season to secure labour by payment of advances. In these occupations labourers work in small gangs, and the arrangements are made with the head of the gang. There is a natural flow of labour, too, to the Bombay cotton mills, and to the Mysore gold mines, which draw their workers from the coast districts. In the same way labour flows freely to Burma, both from the United Provinces and from the coast districts of Madras, and to Ceylon from the ports of Southern India. Recruitment for the colonies is carried on by agents at Calcutta and Madras, who have recruiters working up country under their supervision. As for Assam, there is now a free flow of labour to some districts, but most gardens recruit through their own *sirdars* or headmen, who are supervised by recruiting associations working in the labour districts. For the coal mines, the Committee of 1896 recommended the establishment of a Central Recruiting Agency at Benares; but owing to the difficulty of combination among the various collieries no action was taken in this direction. Each manager works independently, and has frequently to send one of his staff to bring labour from more or less distant places. Spasmodic efforts at recruitment have also been made for the Cawnpore mills at times when labour was scarce, and though Cawnpore is not far distant from the great recruiting grounds of Gorakhpur and Behar, men have been brought from places as far distant as Ajmere and Alwar. Such isolated attempts at recruitment have seldom been successful. The persons recruited have little idea of the work for which they are engaged. They are not used to any but agricultural labour, and when taken far from their homes and introduced suddenly to the dark recesses of a coal mine or to the noise and whirr of a cotton mill, where all is new and strange, they take alarm and usually desert to their homes or to follow some more congenial occupation. Their tendency to do so is encouraged by the old hands, who resent the introduction of competition from a distance and exaggerate the hardships of their life in order to frighten away the new comers. In such cases it used to be customary to bind the men recruited by agreements under Act XIII. of 1857, but it was soon found that agreements had little effect in holding the workers to conditions which they disliked, and their use has been now almost entirely abandoned. For distant colonies special recruitment is, and probably always will be, necessary, because the great expense and difficulty of communication preclude a natural flow of labour. The development of communications in and with Assam, and the improvement of the condition of the labourer in that province, should in a few years enable it to attract labour freely. No fact was more clearly established from our inquiries of 1906 than this—that in an established industry the workers themselves are the best, and indeed the only, satisfactory recruiting agency. They remain constantly in touch with their homes in the recruiting districts, and if they are content with the conditions of work prevailing in their own industry they will introduce their relatives and friends to it. Those relatives and friends will go under the guidance of the old hand, and with full knowledge of the conditions under which they are to work. And so will arise a constant flow of labour sufficient to meet the wants of that industry, even though it be expanding at a considerable rate.

A remarkable example of this natural recruitment came to my notice when visiting the Warora Colliery, in the Central Provinces, in 1905. One Bhawani Din Dikkit of Bhitargaon, in the Rai Bareli district of Oudh, was in the service of the Great Indian Peninsular Railway engaged on bridge construction, and came to Warora when the first pit was dug there in 1872. Impressed with the earnings which could be made at cutting coal, he went to his home and returned with a few men of different castes. These, being satisfied with their conditions, brought others; and when I visited the colliery, thirty-three years later, this same Bhawani Din Dikkit was in a position of trust, and a free flow of labour between Oudh and this colliery, distant some 700 miles by rail, had been long established. And not only this, but their acquaintance with Warora has familiarised the people of Rai Bareli and the adjoining districts of Unao and Pertabgarh with coal mining generally, and attempts, partly successful, have been made to introduce them to the Bengal collieries; but the conditions there are not so well liked by the up-country men, and it is only to a few of the Bengal mines that a free flow of up-country labour has been established.

Thus the supply of labour for an established industry depends on the conditions of labour prevailing therein. If the conditions are popular, labour will come in of itself, and will

stay. If, however, they be unpopular, special measures of recruitment will have to be adopted. Labour will no doubt be brought in, but at considerable expense, and it will not stay, so that further measures will very soon have to be taken to renew the supply.

Conditions of Labour.

It is only in exceptional cases that the resident of the congested districts who migrates in search of work wishes to cut himself off entirely from his ancestral village. As a general rule it is but one or two members of a family who go, and they want to return as soon as possible. Perhaps the most popular form of labour is that which gives good wages paid at frequent intervals for a few short months of fairly strenuous work. These conditions are fulfilled in the jute presses, brickfields, and docks of Bengal. The work is piece-work, wages are paid daily or weekly, and the season is short. Work is carried on mostly in the open air, and the worker has considerable freedom. If, on the other hand, circumstances in his home are such as to induce a man to emigrate with his family, he settles down contentedly enough to labour in a jute mill, where the work is regular and there is remunerative occupation for women and children. Owing to the prevailing system of working in shifts, hours for the individual are not excessive, and wages are paid weekly. The jute mill worker takes an occasional holiday to visit his home, and looks forward to ending his days in his own country. The cotton mills in Northern India are not so popular with the labourer. The hours are long and sometimes excessive, while wages are paid for one month in the third or fourth week of the ensuing month. Of the rate of wages there is no complaint. Indeed, a writer in the *Pioneer*, in 1905, went so far as to attribute the scarcity of labour then prevailing to the high standard of wages. He argues as follows:—

> "The standard of comfort, the social condition of mill hands in the mufassil is very low: their needs are few and of the simplest. They have no use for money beyond their present needs, and, being improvident in the extreme, when they find themselves in possession of more money than they can spend, they stay away from work till it is all gone and only then return. . . . This ought not to, perhaps I should say would not, occur if there were labour available; but it is not available in Cawnpore, and the only remedy is to import it from outside."

He then goes on to point out how attempts at special recruitment from a distance have failed, a matter which I have already discussed above. But he does not see that the whole question is one of conditions of labour. An analysis of the hands employed in one of the larger Cawnpore mills shows from what a wide area the labour supply is drawn. Of 2,122 persons employed 872 only were born in Cawnpore city. The remaining 1,250 were derived from all the surrounding districts, and there are no less than nineteen districts which supplied ten or more persons to this total. It is, therefore, plain enough that the conditions of labour in Cawnpore must be well known far and wide in the country side, and that if the work were well liked labour would flow in of itself to meet any local deficiency and to force the local hand to attend regularly if he is to retain his employment.

And in this connection the establishment of closer relations between the employer and his men is a very important matter. Conditions cannot be improved or grievances remedied unless the manager is in closer touch with his people. In jute and cotton mills the custom is for the manager to depend on his jobbers (known as *sirdars* or *mistris*) for his labour supply. Now, in Bombay these men are, I believe, drawn from a superior class, and in some cases, at least, have been educated in the Victoria Jubilee Technical Institute, but it is otherwise in Calcutta and Upper India. Here the jobbers are men of the coolie class, who have reached their present position by superior cleverness. The system of depending on them saves trouble to the management, and no doubt has some advantages. For instance, in some of the mills on the Hooghly the coolie lines are owned by the jobbers, and it is to their interest to attract labour to the mills, so that their houses may be filled. But the system is open to great abuses. The worker has to pay a fee to the jobber for engaging him, and is very frequently in his debt. The jobber's control over the labourers is complete, and he can at times dictate his own terms to the management. On the other hand, he is of little service when labour difficulties appear, for it is to his interest to fish in troubled waters. A closer connection of the management with the *employés* would naturally stimulate the provision of suitable dwellings and of schools, the formation of superannuation, pension, and benefit funds, and other measures to improve the condition of the worker, and so lead to the establishment of a full and regular supply of labour, and to the prevention of strikes.

Strikes.

For although there are no trades-unions in India, and associations of mill hands, though some such are in existence, have not as yet succeeded in gaining much influence, so that there is no combination between the workers of different factories, yet strikes in individual mills are by no means uncommon, and they are entered on for the most trivial and insufficient reasons. Thus the Calcutta correspondent of the *Pioneer* reported as follows on the 30th January last:—

> "A curious strike has occurred at Rajganj Jute Mill. Last week the men struck because an European assistant had wounded a boy with an air gun. They demanded the dismissal of the European as a condition of resuming work. This was done, but they now wish the assistant to be reinstated. The management have refused their demands, and a number of men have gone on strike again."

Then political agitation, scares and religious disputes, with which the management have little or no concern, are frequent causes of disturbances among mill hands, and the manager would have much more chance of bringing his men to reason if his relations with them were on a closer and more friendly footing. The Tilak riots last year in Bombay and the Hindu-Mohammedan disturbances in Calcutta at Christmas will be in your recollection, and very serious riots, in which several lives were lost, occurred on the Hooghly some years ago, owing to an unreasoning dread of the enforcement of drastic measures for plague prevention.

Efficiency and Education.

I have but little time left in which to discuss the efficiency of Indian labour, and perhaps it is just as well, as there is no subject on which I have found it more difficult to arrive at definite conclusions. Thus we are told that a female weaver in England looks after six looms, while a male weaver in India can only manage one; but the more usual number of looms per weaver in England is probably three, and it is not uncommon in India for one weaver to manage two looms. In coal-mining, Mr. H. H. Macleod, of the Bengal Coal Company, recently stated that the efficiency of the Indian miner is only one-fifth of that of the Englishman. Chinamen, owing to their industry and avoidance of waste, make excellent carpenters and shoemakers, and very large numbers of them are employed in Calcutta in both capacities. As carpenters they command three times the wages of natives, and in 1905 Mr. R. P. Ashton of Calcutta advocated their introduction for certain highly skilled labour in cotton mills and as overmen in collieries. Nothing has been done to carry out this suggestion. But, on the other hand, it is beginning to be recognised that cheap labour is by its very nature inefficient, and cannot compete with labour-saving appliances.

In the last few years there has been a considerable advance in this direction. Electric cutting plant has been already introduced into some collieries, and a syndicate has been formed to construct a central power station to supply a large portion of the coal-fields with electricity. In many industries hand labour is being displaced by machinery. Cotton is now hardly ever spun by hand, and power-looms have to a great extent supplanted hand-looms. The importance of the hand-loom weaving industry, which is still second only to agriculture in the number of people to whom it gives employment, has, however, received increasing recognition during the last few years, and it is hoped that by the introduction of the fly shuttle and other improvements the efficiency of the hand-loom may be so enhanced as to enable it to compete successfully with the power-loom in certain classes of goods. Even in agriculture labour-saving appliances are making their way. A considerable demand has arisen in the Panjab canal colonies for automatic reapers and winnowers, while throughout India the number of motor pumps and steam flour-grinding and cane crushing machines is rapidly increasing.

Intimately connected with the question of efficiency is that of education, both primary and industrial. In both respects India, and especially Northern India, is very backward, but considerable progress is being made. Primary education leads to greater efficiency and regularity of labour. At present the Indian operative is charged with being indolent when not fully supervised, wasteful of material, irregular in attendance, and without any idea of provision for future wants. There is much truth in the indictment, though slackness and irregularity are a necessary corollary to the long hours for which it is customary to work. And the mill population is, as has been shown above, peculiarly liable to disturbance by ill-founded rumours and unscrupulous political agitation. The main remedy for this state of affairs is primary education, which induces a more reasoning frame of mind, a

higher standard of comfort, and a higher sense of duty. At present the large and increasing factory population is growing up entirely without instruction, and I could wish that the recent Factory Labour Commission had reported definitely in favour of compulsory schooling for half-timers. So long as reliance is placed on a voluntary system it is not likely that much progress will be made. Then, again, there is a general complaint in Bengal and Upper India of the scarcity and inefficiency of trained artisans—carpenters, masons, fitters, turners, moulders, &c. This is a matter which can only be rectified by a large extension of the facilities for industrial education. It is only recently that the subject has attracted the attention it deserves, and something is being done to supply the want. But progress is very slow. In the writer's opinion, vernacular industrial schools, teaching drawing and the use of hand tools, should be established in every district, and industrial classes for apprentices should be attached to all factories where Government work is being carried on. It is in this way that practical and theoretical work can best be co-ordinated, and the leaning of the people to a literary education be diverted to more practical ends.

Conclusion.

I have shown that a marked development is in progress in certain organised industries, and there is also a distinct revival in some indigenous industries; while in agriculture by far the largest industry of the country development is slower, but signs are not wanting that an advance is being made. In many directions, however, development is hindered and hampered: by lack of capital and of enterprise on the part of a few who possess it, by the want of technical and industrial education and perhaps by the absence of a tariff wall, under whose shelter new industries could be created, and decaying industries revived. The normal growth of the population should be sufficient to provide all the extra labour required, and recent improvements in communication have facilitated migration from the congested districts to the great industrial centres. Temporary labour difficulties may, of course, arise, but the Indian worker is tractable, teachable, and adaptable, and no fear need be felt that, given fair conditions of labour and sympathetic treatment, there will ever be a serious shortage of labour in any field of industry.

DISCUSSION.

The Chairman (Viscount Midleton) thanked the author for the admirable digest he had given of the present position with regard to the labour supply in India, and the manner in which he had put forward the result of researches, which had been of a prolonged and important character. It was possible, however, in dealing with the conclusions which the author had drawn from the facts, that those who looked on from a distance at what was taking place in India might arrive at a somewhat divergent and more optimistic view than that entertained by one who had closely studied the question on the spot. In his concluding paragraph the author said:—"In many directions, however, development is hindered and hampered by lack of capital and enterprise on the part of a few who possess it, by the want of technical and industrial education, and perhaps by the absence of a tariff wall, under whose shelter new industries could be created, and decaying industries revived." He (the Chairman) did not intend to carry the audience away to the fruitful field of discussion which was opened by that paragraph, because he had before him the fear of his friend Sir William Lee-Warner, with whom he had the honour of serving at the India Office, and who would be willing to open a battery upon him if he were to attempt to forestall the action of the Indian Executive on that very important and much-disputed proposition. But without going into that subject, he wished to put a little of the burden on the back of the Indian Executive, both at home and in India, whom for obvious reasons the author would not desire to criticise. Nobody could doubt that the labour difficulties which had followed the great development of trade and industry during the last thirty years had largely been accentuated by the fact that the Government of India had not been able to meet beforehand the demands arising out of that development. He did not criticise those who had sat at the India Office or in the Council Chamber in India in the past if they had been in some respects remiss in that particular. They had had to consider finance. At a critical moment in the development they had had a great difficulty to meet in the fall of the rupee. They had had their share of famine, of war and of other drawbacks which had mortgaged their revenue, and had made it unwise perhaps for them to enter on the very large expenditure which must be carried on for a long time ahead. But making all reservations, the fact could not be denied that the railway development of India had been altogether insufficient for the business which that country was able to transact. If a search was made all through the world it would not be possible to find, as far as he knew, any country except China, where such a copious supply of passengers would be found as in India for any new line, and where the whole of the railways paid over 4 per cent. on the capital expended. It stood to reason, therefore, that if in the last thirty or forty years it had been found possible in India to take time by the

forelock, to take advantage of every fall of rate in the City when money was easy to get, if the Indian Government had gone ahead, and spent 10 million a year from 1885 to 1895 and from 1895 to 1905, as was being done now, he believed many of the difficulties which were incident to migration, and the supply of imported labour could have been overcome. The author in the course of his excellent paper had used the word "popular," more than once—the supply of labour would come if the conditions were popular. He did not think he would be controverted by those who knew far more about India than himself if he said that what had to be created in that great matter was not merely popularity; they had to accustom a people who were very sedentary to a change of habit. A great mass of population accustomed to work in places where the pursuits were agricultural had to be accustomed to work elsewhere in pursuits which were not agricultural. This was in itself an enormous change. To accustom Orientals who lounged through a comparatively easy day in their own time to piece-work and to all the incidents of factory and commercial life, would not be accomplished in five or ten years. The author stated that technical education was badly wanted. One of the things in which India had been most backward was that in which this country had also been most backward, namely, technical education, even among the higher classes. He believed he was right in saying that, at the present moment, there was practically no trade education in the proper sense of the term in India at all; and if they wished men of the higher class, who had capital, to embark it in new factories and fresh industries, it was necessary to give them an education, which would show them the advantages of commercial enterprise. That again, was a point where Government had, perhaps of necessity, lagged behind. Once it was realised that the main conditions of communication and education had not been present, they could hardly wonder at the difficulties which the author had found in meeting the needs of a system which was novel with machinery which was obviously out-of-date. There was always the difficulty in trade of the reconcilement of new conditions in the case both of employer and employed. Previously workers had not been able to earn anything like the wages which the author stated had now to be paid. If it were true that one female weaver in England could look after six looms, and one male weaver in India could only look after one, obviously the old agricultural wage would not be far short of the mark. But the author had stated that, when improvement was shown by the workers, it would no doubt pay the employer to give the employed better wages, and thus a desire would be felt by the employed to avail themselves of the larger sum. If the old condition of things were to continue, he had not the least doubt that the tariff reformer in this country would feel a greater security than he now felt against low-priced cotton labour under-selling goods for which the trades unionist had higher rates in this country. In dealing with the labour problem of India, he thought they were not only dealing with a most interesting administrative question, but one of the highest Imperial significance. India was passing through a great phase, in which one of the greatest difficulties had been that to a very large class of people a considerable amount of higher education had been given, but they had been left a very small outlet for their energies beyond agitation. Personally he believed they had, in the highest avocations of trade, an outlook for India which, in almost every Western country, had provided a great class, naturally loyal and naturally conservative in the sense of desiring the preservation of that which they had, and the conditions of law and order without which their economies, trade, and avocations could not possibly succeed. They wanted in India to draw in those who were educated more highly, not only into the paths of law, and, as far as they were fit for it, into the paths of Government, but also into the paths of commercial industry. They would look in vain for any country where men were employed profitably, and had industries and careers open to them, where agitation continued, and where want of contentment and unrest was the order of the day. If illustrations of that nature were required, it was possible to draw them from other countries, but, at the same time, it also gave to those who were exercised about the question a feeling of hope. It was not to be expected that all the difficulties would be redressed in the next decade. For instance, taking this country, if one looked at what Lord Beaconsfield conceived to be the drawbacks to the trade and the conditions of the life of the people in the year 1837, as set out in one of his early novels, "Sybil," one could not help being struck with the picture which he drew. But if one looked further into the matter it would be seen that hardly one of the evils on which Lord Beaconsfield dwelt, were corrected in this country, with a popular Government, before the year 1886. That was a very considerable statement for a Conservative to make, and he called attention to it because it showed that in this, as they hoped the most progressive of all countries, it took fifty years to bring about the amelioration of the conditions referred to, and which brought about a large population eager to avail themselves of the opportunities given them of employment. If that was the case with regard to this country, they must not therefore despair if time was needed in India. To take another instance, in the north of Ireland, most successful and most prosperous industries had grown up, giving a most loyal and contented population, and in the portion of Southern Ireland which possessed the means of communication similar progress was beginning, but almost the same length of time had been necessary to bring it about. He was, therefore, not without hope that, while so great a service had been recently done to this cause by the steady and persistent effort of the Indian Government with regard to railways, by a still more liberal use of technical and trade

education, they would succeed in helping those who were on the spot, in bringing to a successful issue that very great and important question.

Mr. H. LUTTMAN-JOHNSON thought there was no doubt whatever that there was an ample supply of labour in India for any industries which might be started there. The difficulties which had occurred in obtaining labour had been of a temporary nature, and were by no means permanent. For instance, there was no want of capital or labour when one of the greatest industries that existed in India was started, namely, the tea industry. There was no labour in the districts in which the tea grew, but the people who started the industry were able to import labour from other parts of the country, and for many years obtained as much as they required. The system, however, gave rise to certain abuses. It was stated that the coolies were worked too hard, and that they were practically in slavery, so Government interfered, and made it difficult for the tea planters to import labour into their districts. Before a man was engaged to go to the tea districts he had to be taken before a magistrate, which made him think it was a terrible place he was going to, while the name of Assam was also hateful to the Hindu. But in spite of their artificial difficulties and the natural difficulties of the situation, many millions of money had been sunk in the tea gardens, and they were now fairly prosperous. Some people had hoped that the difficulties put by Government in the way of recruiting for the labour supply of Assam would have been removed after the 'Commission's Report, but unfortunately that hope had not been realised. Certain arrangements, which were not very material, as to the conditions of labour in the tea districts had been altered, but the great difficulty that the Government placed in the way of emigration from the labour districts to Assam had hardly been changed, and, as far as he could ascertain, it did not really propose to change them. He gave that as an instance of how, where there was plenty of labour available, the interference of Government, although it might not stop the development of industry in India, might make it much more difficult than it otherwise would be. He thought the best thing to do in regard to such matters was to adopt the Cobdenite principle of leaving things alone, and then it would be found that people would go where they thought they would do well.

Mr. T. J. BENNETT, C.I.E., said that everyone who had any connection with the industries of India could take no other view of the paper than that it was an informing, discriminating, and very cautious survey of the actual state of labour conditions in India. He should not even hint a disparagement of it if he said that it illustrated in some degree a difficulty which was commonplace in dealing with all Indian questions, namely, that of generalising in regard to the economic or any other factor. The author had been very candid in the way in which he had spoken of Bombay. He thought if the terms of Mr. Fremantle's Commission, which were limited to Upper India, had included Bombay he would have given a somewhat different account of the labour conditions in that city than he had done. The last three or four years had been a time of great difficulty in the labour market of Bombay. The pressure just now was not perhaps as great as it was, but he remembered the time within the last three years in which it was almost impossible to obtain coolie labour in Bombay. At one time from 1 rupee to 1 rupee 8 annas was being paid to a coolie, an almost incredible rate of wages, if it was remembered that 6 to 8 annas was a normal rate of pay, even in well-paid Bombay. The reason for that had been possibly because of the prosperity of the city. In a boom in the cotton industry wealthy millowners made more money than they had made for some years, which they put into houses. In addition to that, Bombay had been enlarging its already enormous dock accommodation, something like three crores being spent upon it, and that had made a large demand upon the supply of labour. Those, it might be said, were passing difficulties. Plague might at one time have been included amongst the labour difficulties of Bombay, and those who could look back to the early part of 1897 would remember the aspect of the deserted city when two-thirds of the population had taken flight. As might be well realised, that was a time of exceeding great difficulty. But he thought any employer of labour in Bombay to-day would say that the fear of plague, which was quite distinct from the fear of plague measures, had passed away, and that it was no longer an important factor in the labour problem. Anyone who had acquaintance with the practical side of labour in Bombay would support him in the statement that the difficulties of labour would form a very rich subject for discussion. There was, first of all, what might be called the psychological side of labour difficulties—difficulties connected with the temperament of the people, their distrustfulness, and their suspicion. There was a sort of "hair-trigger" sensibility which had to be respected and carefully guarded against. It was necessary to deal gently with the labourer if one wished to carry on one's operations smoothly. It had also to be borne in mind that in India one was not dealing with the economic man of the old economists—by that he meant a man who, under the stimulus of the expectation of increased gain, would put forward increased effort; and that was a difficulty which differentiated Indian labour problems from those in this part of the world. Illustrations of that sort came before one every day. For instance, if one had a pressure of business, and wished to push through quickly, and offered the labourer an increase of 50 per cent., he would give 50 per cent. less work, and the employer would be the worse off. An illustration of that which came to his own know-

ledge, not long ago, was in a department in a certain industrial establishment in Bombay, which was changed from time work to piece work. The men had been working terribly slowly under the old régime, and they were delighted when it was shown to them that they would double their pay if they worked reasonably well under the new system. Everything went beautifully, and at the end of the first month the men were astonished to find how much they had made. But after two or three months they became dissatisfied; they had nothing to complain of, nothing was wrong, but they preferred the old way. That illustrated the fact that in India they had to deal with status and custom more than with contract. He noticed the author had, towards the end of his paper, referred to various means by which the quality of labour could be improved and labour difficulties could be reduced, one being increased education and the other better housing of the people. He noticed that because the author gave what he thought would be a valuable and efficacious support to an argument that was put forward in Bombay about three weeks ago by the President of the Bombay Millowners' Association, Mr. Fazulbhoy Currimbhoy Ebrahim, a Mohammedan gentleman who, as a captain of industry, reflected credit upon the commercial and industrial life of Bombay and upon the Mohammedan community. That gentleman spoke very seriously indeed of the urgency of the housing question in Bombay. How urgent it was could be realised from the fact that recently a mass meeting of mill workers made a representation to the Improvement Trust in Bombay, impressing upon them the necessity of providing more houses so as to reduce the high rents of the mill hands of Bombay. The education question was also strongly impressed upon the municipality by the President of the Bombay Millowners' Association. Where better housing had been provided there was no doubt that the difficulties of mill management had been mitigated, a millowner in Upper India having told him that he had very little difficulty with his mill hands, for the reason that he had provided them with comfortable housing. The men did not leave their work and go up country as the mill hands in other districts did where proper housing was not provided. He thought it was the fact that industrial labour was getting scarce in Bombay. The old notion that there was an inexhaustible supply of cheap labour in India would have to be revised. He did not think it was inexhaustible and he knew it was not cheap. The mere fact that it had become a question of argument and discussion at the present time seemed to put out of court altogether those who had most confidently year after year said that India was being drained of its wealth, and that it was becoming more impoverished. If there was anything at all in the proposition, which was constantly put forward, that labour was getting scarcer and dearer, the old argument that India was economically deteriorating under British rule had no foundation whatever.

Mr. John Ferguson, C.M.G., said that by far the greater portion of the emigration from India was to the island of Ceylon, which he represented. Ceylon employed more natives of India than the rest of the world put together, a fact which had been an unmitigated blessing, not only to Ceylon, but to the southern districts of India from which the coolies came. He remembered some years ago hearing the late Sir Charles Bernard describe the population of Southern India, from which the coolies were drawn, as numbering from ten to twelve million people, who, if they obtained the equivalent of half-a crown per week per family of man, wife and two or three children, were as well-off as any people on the face of the earth; but inasmuch as in most years they seldom exceeded 1s. 6d. a week, they were always on the verge of distress and famine. The coolies who had come from India to Ceylon were the means of enabling the planters to develop the great coffee industry of the island, the still greater tea enterprise which followed when the coffee industry declined, and also the cocoa (cacao) and the great rubber industry which had now sprung up. The Cingalese, the indigenous population, would not do field work for the planter, devoting themselves to the cultivation of rice and palms, the latter of which was a very large industry in native hands. The rice industry, however, could not supply the want of the emigrant coolies, much less of their town populations, as it was found that the Cingalese, even after the abolition of the paddy rent or tax, had not extended the cultivation. The import of rice from India had in fact more than doubled since the local industry had got a 10 per cent. Customs duty in its favour, and Ceylon paid India now nearly four millions pounds sterling a year for this. The Tamils from India were a most contented people because they were free men. They had no indentured labour, and the planter who was recognised as a good planter by his employers was the man who was popular with the coolies, and obtained an ample supply of labour. Of late years a scarcity of coolies had arisen owing to the rise of the great rubber industry. Two hundred thousand acres of rubber had been put under cultivation, mainly within the last five years, but the difficulty with regard to labour supply had now been overcome, and indeed the Singalese were expected to help in such simple work as collecting the rubber latex or milk, as many of them did the plucking of the tea plant. The coolies who came from the southern part of India stayed for some years and then carried back their savings with them. Those that remained generally had little gardens in connection with their homes in the hills, where they cultivated vegetables. They settled down in the country and the children born to them almost invariably regarded Ceylon as their home. He was thankful that no Chinese had been imported in India or Ceylon, because wherever they went considerable trouble arose in connection with their administration. He entirely sympathised with what the author had said with regard to education.

Those of the people who were educated often rose, became landowners, and useful settlers.

Mr. P. J. HANNON regretted that the author had not referred to the possible influence of the co-operative movement in India on the labour supply. He had been identified for a great many years with the development of co-operation among very poor people. One of the most hopeful effects of this movement was that the spirit of industry and the desire for thrift and work were stimulated. The Chairman had referred to the condition of things which existed in Ireland at one time. He thought that, within the last twenty-five years, there had existed in certain parts of Ireland conditions, from the labour point of view, not very much better than they were in India to-day. There the introduction of co-operation had had a marvellous effect. If one looked back on the work which had been done since the co-operative movement was introduced into India, six or seven years ago, it would be found that very useful influences were at work in the various districts in directing the attention of the Indian peasantry to industrial pursuits. In the Report of the Conference on Credit Societies which took place at Simla in 1906, reference was made to a number of industries to which it was thought the principle of co-operation could be applied. It was suggested in the weaving industry, particularly silk weaving, and the sugar industry, that a co-operative movement might be encouraged with beneficial results. Perhaps the author would be able to state, not merely what had been done in that direction, but how far it was likely that co-operative effort would be successful. At the end of his paper the author referred to the question of a tariff wall being put round India. He did not think it was the province of the Society to discuss the question as it suggested itself to one's mind at the moment, but in the fiscal problem now before the country one of the most difficult considerations was the position of India. It appeared to him to be eminently satisfactory that the Indian labour supply was, at the moment, apparently adequate and well-organised, and it was also intensely interesting from the Imperial point of view, because it would be found, on looking into the rapid development of the sea-borne trade of India, that since 1897 the whole of the trade with all the countries in the world had been practically doubled. In the financial year 1896-7 the total sea-borne trade was 132 millions, in 1905-6 it had risen to 214 millions, and in 1907 to 242 millions. It was very important to know that in a great country developing so rapidly as India was, and affecting as it did the whole prosperity of the Empire, the labour conditions at the present moment were in a satisfactory state.

The CHAIRMAN moved a vote of thanks to Mr. Fremantle for his valuable paper.

Sir WILLIAM LEE-WARNER, K.C.S.I., in seconding the motion, expressed the hope that Mr. Fremantle would print in capital letters the adverb "perhaps" with which he had already qualified his partial approbation of a tariff wall. India's needs for cheap imports, and for open doors to every market in the world for her exports, by which she paid her foreign debt, were imperative. He was very glad to notice the stress laid on freedom of labour. The "sun-dried bureaucrats," of whom we had lately heard so much, could look back with satisfaction on the progress of India from the status of slavery first to a system of contracts, and happily now to the full recognition of the value of free movement of labour at the option of the labourer. The speaker remembered in his time taxes imposed in Native States on men leaving or coming into a village, on marriage with aliens, on goods passing through markets, and generally a comprehensive system of opposition to freedom of men and goods. Now it was perceived that if the conditions suited labourers they would soon come of themselves to new fields of labour without compulsion or even formal contracts. That at least was one of many results of British rule which the Portuguese or the Belgian rulers of over-sea dominions might well take to heart. It was also a healthy note in the excellent paper read which was struck on the subject of education. All large employers of young labour, whether the State or private manufacturers, ought to be obliged to provide the means of acquiring primary education. In asking all present to express their sense of obligation to the author, he would ask them to remember also the Chairman, who by his presence and his speech had added to the interest of an interesting afternoon.

The resolution of thanks was then put, and carried unanimously.

Mr. FREMANTLE, in reply, after acknowledging the extremely kind manner in which the vote of thanks had been proposed and carried, said the Chairman had referred to the lack of the development of railways as one of the causes that hampered the development of industries. Whatever might have been the case in the past in that respect, he did not think it could be said with regard to the present, because there had been a very considerable development in the last 10 years. The congested districts had been very well opened up by railways, and every village was now within 20 or 25 miles of a railway. Of course, the more railways were developed the more opportunities there would be for labour. Mr. Luttman-Johnson had said that certain difficulties still remained to be removed with regard to the free movement of labour to Assam. He was afraid he had not sufficient knowledge of local politics to dispose of that gentleman's objections in any way, although Mr. Luttman-Johnson did not state very clearly what they were. He was very sorry also that he could not answer Mr. Bennett's remarks with regard to Bombay, as he had not any personal experience of that presidency. The remarks which had been made as to the importance of the housing question, especially in Bombay, were

however, very true. He had had a good deal to do with he co-operative movement in India, to which Mr. Hannon referred. There was no doubt of the extent to which the spirit of industry was stimulated by co-operative education and co-operative societies of different kinds. As co-operation extended in the towns, he thought it would do a great deal towards removing the difficulties connected with local labour. Co-operative production had been tried in India, but he was afraid he could not say it had been successful. But they were only at the beginning of things yet, and it was possible that certain productive enterprises might be successful, but so far there was no sign of it. Co-operative education might be joined to primary and industrial education as one considerable factor in inducing a proper spirit of industry.

Mr. G. W. CHRISTISON writes to call attention to the great injury caused to the tea industry in the Darjeeling district, by the recruiting that takes place in the gardens there for the Gurkha regiments, the police, &c. This grievance is, he observes, bitterly resented by the planters, and is a crying injustice, inasmuch as it deprives them of some of their strongest and most skilful men after the latter have been trained at great expense. He strongly appeals to the Government in India to put a stop to the practice complained of. Mr. Christison also points out that a serious scarcity of labour exists in Darjeeling as a result of the famine prices of food in the district during the last two years.

Mr. A. MCROBERT, Ex-President of the Upper India Chamber of Commerce, writes:—I was deeply interested in the paper read before the Society on Thursday by Mr. Fremantle on the "Problem of Indian Labour Supply." Mr. Fremantle is to be complimented on his luminous treatment of a difficult subject. Had there been more time I would have liked to take part in the discussion as my name was mentioned, and I happen to know something of the great pains Mr. Fremantle has taken to get at the views of the workers themselves. The employers are vocal enough but the workers are for the most part dumb, and the results of Mr. Fremantle's laborious inquiry gave an inkling of what is often at the back of the native's reluctance to devote himself to factory work. There is one rather important point that was not alluded to by any of the speakers. In this country an operative who throws up his work is likely to starve, and he knows it. In India the family system gives the coolie the assurance that whatever happens his "brethren" will keep him, and he is, therefore, ready to go on the unemployed list for small reason or no reason at all. The inefficiency of the Indian factory worker was referred to. At bottom this is no doubt to be accounted for by the fewness of his wants and the lowness of his standard of comfort. Accustom him to more comfort in living and he will be more anxious for steady employment. This means higher pay, but not necessarily a more expensive workman, for both the quantity and the quality of the work would be raised. I dare say the average coolie instinctively feels that whatever change he may make he cannot be worse off, and he moves on accordingly. In this country 75 per cent. of a labourer's earnings go in food and rent, the latter amounting to at least three or four shillings a week for indifferent accommodation. In Cawnpore, where I have been in close touch with factory labour for twenty-five years, the worker, for a penny or twopence per week, can get quarters at least as comfortable in relation to his requirements. Two of the larger factories in Cawnpore, have already provided some 1,500 houses of a superior sanitary type which are rented to the workers at twopence per week. These houses are not yet popular—perhaps because they are too good, but the hope is held that the workers will gradually learn to live up to their environment. The effect on the death-rate has been very striking. The death-rate in these settlements for the past three years has been under 25, while the like figure for Cawnpore city and district is over 60. The residents in these villages are also rather more regular in their attendance than those of the workers who live elsewhere. This is just the result which Mr. Bennett expects to follow improved housing. Comparatively short hours of labour do not seem to be any particular attraction. One textile factory in Cawnpore has an average day of under 10½ hours, while others round it nominally run 12 or even 13 hours, and the latter are often actually better off for hands than the former. Workers have been known to throw up their posts in a factory to go on famine relief works. A factory hand is rarely proud of doing his work well. His object first and foremost is to get to pay-day by the easiest possible road. I have probably said enough to show the value of Mr. Fremantle's contribution, although my remarks do not pretend to be anything but sketchy.

NINETEENTH ORDINARY MEETING.

Wednesday, May 12, 1909; PROFESSOR J. M. THOMSON, F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Bishop, Rookwood Comport, J.P., Christchurch, New Zealand.

Chujo, S., 21, Sendagi-Hayashicho, Hongoku, Tokyo, Japan.

Clutton-Williams, J. P. C., Ph.D., F.S.S., care of Messrs. Balmer, Lawrie and Co., P.O. Box 4, Calcutta, India.

Harrison, C. W. Francis, Natal Government Offices, 26, Victoria-street, S.W.

Hay, Lieutenant John A. L., R.N., 13, Little Grosvenor-street, W.
Penn-Simkins, George, care of Messrs. Thomas Cook and Son, P.O. Box 26, Calcutta, India.
Smith, Thomas Fison, 4, McLean's-buildings, New-street Square, E.C.

The following candidates were balloted for and duly elected members of the Society:—

Azam, Khan Saheb Khwajah Mohammud, Dilkosha-garden, Dacca, Eastern Bengal, India.
Clarke, Percy, 13, Fleet-street, E.C.
Goolamhusein, Khan Bahadur H. M. Malak Budrudin, Medhi Bag, Nagpur, India.
Greaves, Mrs., 58, Westbourne-park-road, W.
Guy, Frederic John Vavasour, M.P.S., Kuala Lumpur, Selangor, Federated Malay States.
Habakkuk, William, M.Inst.M.M., 459, Grande Rue, Pera, Constantinople, Turkey.
Hack, Walter P. Pearson, Khartoum, Soudan, Egypt.
Matson, Ralph C., M.D., 1021, Corbett-building, Portland, Oregon, U.S.A.
Menon, T. Kunhi Krishna, B.A., M.R.A.S., Ernakulam, Cochin State, Southern India.
Nakamura, Z., President, South Manchuria Railway Company, Dairen, China.
Nonomura, Kingoro, South Manchuria Railway Company, Dairen, China.
Pet, Maung, K.S.M., Konwindat Quarter, Tavoy, Burma.
Ridsdale, Herbert Wheatley, Hill House, Burnham-on-Crouch, Essex.
Robertson, Lieut.-Colonel D. K., 8, Cadogan-mansions, Sloane-square, S.W.
Sen, Bankim Chandra, M.R.A.S., 17, Charles-street, Haymarket, S.W.
Somake, Moses J. H., McLeod-road, Karachi, India.
Volckman, George William, 197, Sparks-street, Ottawa, Canada.

The CHAIRMAN said that although this was an ordinary meeting of the Society, a lecture would be delivered by Professor Dendy under the Aldred Trust. He hardly thought it necessary to remind those present what that Trust was. It was founded as an essay prize very many years ago by a certain Dr. Aldred, a physician in the Indian Army, and the Council of the Society determined that the money so founded should accumulate until sufficient funds had been provided, and that, instead of an essay, lectures should be delivered as circumstances permitted. That, shortly, was the origin of these lectures. Last year Sir William Ramsay delivered a lecture on his own recent discoveries in Radio-activity, which dealt with the advancement of physical science, whilst this year the Council had gone into another branch of science and had asked Dr. Dendy to give the second lecture. He thought the Society was greatly privileged in getting so distinguished a professor of Natural History as Dr. Dendy to deliver the lecture, for he came before them with experience not only in this, but also in another, hemisphere.

The paper read was—

THE ALDRED LECTURE.

ON THE PRINCIPLES OF HEREDITY AS APPLIED TO THE PRODUCTION OF NEW FORMS OF PLANTS AND ANIMALS.

By ARTHUR DENDY, D.Sc., F.R.S.,
Professor of Zoology in King's College (University of London).

A friend of mine once told me a story of a certain old gentleman who happened to be deeply interested in his family pedigree. His name was an uncommon one, and this in itself was of material assistance in his researches. He had, however, another great advantage which is not shared by many people—he was the fortunate possessor of six toes on each foot. It may not at first be obvious how the possession of an additional toe could assist him in climbing up his genealogical tree and investigating its various branches, but a little episode in his career will make this sufficiently evident. He was visiting a distant country, and was suddenly confronted with his own name over the door of a chemist's shop. He entered, and, finding the proprietor of the shop behind the counter, very politely inquired whether he also had got six toes. We may imagine his delight on discovering that this was indeed the case, and in being thus enabled to restore a long lost branch to the family tree.

It would be difficult to find a better illustration of what is meant by heredity. It is the transmission, from generation to generation, not only of those more general characters which distinguish one kind of animal or plant from another, but also of individual peculiarities which may be very much less conspicuous than the old gentleman's extra toe. Little tricks of habit, so difficult to eradicate in children, may form part of the endowment which they receive from their parents, just as much as peculiarities of feature; and even such a trifling thing as the manner in which you cross your thumbs when you fold your hands together, may be transmitted from one generation to another.

The explanation of such phenomena as these constitutes the most important and at the same time the most difficult problem in the domain of biology, if not in the whole field of science. The history of the progress of mankind is the history of the wresting of one secret after another from the book of Nature, and of the application of the knowledge thus acquired to the control, for the benefit of man, of the natural forces by which he is surrounded.

The investigations of the physical sciences have resulted in an incalculable amelioration of the conditions of human existence, and have at length paved the way for the attack upon those problems which are more particularly concerned with life itself. The conquest and control of the inorganic world are far advanced. The physical forces of inanimate nature are yoked to the service of man; but what of life? How far can we control, how far can we even hope to control the forces which determine the character of living things, the character of man himself? This is the problem before us to-night, and you will at once see that it is of such a nature that we cannot, in the brief time at our disposal, do more than indicate some of the lines along which the attack is being led, and some of the successes which have already been achieved.

The development of any science may be roughly divided into two stages: the observational, in which it is thought sufficient to observe and record what takes place in nature uninfluenced by human interference, and the experimental, in which the observer puts his own finger into the pie, and thereby intentionally modifies the result. Man might almost be defined as the experimental animal, and the same instinct which causes a small boy to throw a stone at a street lamp, for the pleasure of observing the effect of his action, leads also, when properly directed, to the discovery of such things as radium and wireless telegraphy.

Biology is only just entering upon the experimental stage. We have too long been content to take our walks quietly in the dimly-lit streets of nature, without ever troubling ourselves to break a lamp in order to find out where the light comes from.

Observation, however, has enabled us to survey the ground, nor has experiment been entirely wanting. During the last hundred years we have learnt much of the nature of the problem which we wish to solve. Physical and chemical science have led the way, as they always must. The discovery of the microscope and the improvement of microscopical technique have taught us much concerning the physical and chemical composition of living things.

After the discovery of protoplasm, as what Huxley so aptly termed the physical basis of life, one of the greatest intellectual triumphs of the nineteenth century was the elaboration, by numerous biologists, of the cell theory. We know now that the body of every living organism is, with certain apparent exceptions which do not seriously affect the general result, built up of one or more minute nucleated masses of living protoplasm, the cells or organic units. In the simplest plants and animals, for the most part visible only with the aid of a microscope, the entire body is but a single cell, a single speck of gelatinous protoplasm, usually with a differentiated nucleus somewhere near the middle. From this simple condition, through endless grades of ever increasing complexity, we pass to the higher and larger plants and animals, in which many millions of nucleated protoplasmic cells are united together in one individual body and variously modified in structure for the fulfilment of a vast variety of different functions.

We have also learnt that these microscopic cells are capable of self-multiplication by division, and that it is upon this property of the cell that the growth and development of all living organisms depends, for however complex the adult plant or animal may be, it always starts life as a single cell unit, or, to speak more accurately, of a cell unit which is formed by the combination of two cells, the male and female germ-cells or "gametes."

For some time it was supposed that with the discovery of the cell and its nucleus we were approaching the limit of the microscopical analysis of the animal or vegetable body. The researches of the last thirty years, however, have revealed a perfect microcosm of elaborate structure in the nucleus itself, the outstanding feature of which is the appearance, at the time when division is about to take place, of a number of bodies to which, on account of the avidity with which they absorb certain dyes, the name *chromosomes* has been applied. That these chromosomes must be of vital importance to the organism which possesses them is clearly indicated by several facts. Thus they are nearly always constant in number, not only in all the cells of the body but in all the individuals of any particular kind or species of plant or animal, though differing in number in different species; and at every ordinary cell-

division the equitable halving of each individual chromosome is effected by means of a complex mechanism specially adapted for the purpose, in the elaborate process which is termed karyokinesis or mitosis. No less remarkable is the fact that, at a certain period in the life history of each individual, half the number of chromosomes present are thrown out from those particular cells from which the sexual reproductive cells or gametes are destined to arise. Thus it happens that the nucleus of the germ-cell of an animal or plant, whether male or female, has only half the number of chromosomes which we may consider to be characteristic of the species. But before the egg-cell can begin to divide and thus develop into a new organism, it has to be fertilized by the sperm cell. The act of fertilization consists in the complete fusion of the male and female gametes or germ-cells to form a compound cell or zygote. Each parental nucleus brings with it half the proper number of chromosomes, and thus the zygote, or fertilized egg, starts life with a full complement of these bodies, half of which are derived from each parent.

These facts, thus baldly narrated, but established beyond the possibility of doubt, seem to indicate that the chromosomes are extremely important things, and not a few biologists are inclined to regard them as the actual bearers of the characters which an organism inherits from its parents. We cannot say that this view is yet firmly established, but we shall see that it fits in very well with the results of experiments on heredity, and we may at any rate adopt it as a provisional hypothesis. We must be careful, however, to guard against looking upon even the chromosomes, minute as they are, as simple bodies, for each one is probably made up of many thousands of units which are quite beyond the limits of microscopic vision, and it is these that are supposed to be the representatives, so to speak, of the different characters which are transmitted from cell to cell and from generation to generation.

Observation has thus enabled us to establish the existence of a material foundation for the transmission of characters from parent to offspring. We know that every child, if not exactly a chip of the old block, is certainly a combination of chips from two old blocks, and that the protoplasm which forms the material basis of all living things is continuous by means of the germ-cells or gametes, in an unbroken stream from one generation to another. At each act of sexual reproduction, however, two such streams are mingled, and the offspring receives half its initial stock of protoplasm from one parent and half from the other, each half bringing with it all the potentialities which may have been derived from a long line of ancestors.

We must now direct our attention to the results which have been obtained by the experimental method of attacking the problem of heredity. In the early part of the nineteenth century much attention was paid by horticulturists to experiments on the hybridisation of plants, and many such experiments are, of course, still being frequently performed. It was soon found that, within certain limits, it was possible to fertilize the flower of one variety of plant with the pollen of another variety, and in this manner to alter the character of the offspring. Many crosses or hybrids between different varieties were thus obtained, differing in various ways from the parent plants. It was also found that by repeatedly fertilizing the flowers of one variety with the pollen of another the descendants of the first could be entirely changed into the second. This clearly proved that all the distinctive characters of the male parent were in some way represented in the pollen grains, and could be transmitted by these to future generations, but it also proved something more: it proved that it was possible to eliminate the special characters of the female parent, or at least to prevent them from manifesting themselves in the offspring.

We must remember, of course, that the process of fertilization in plants, as in animals, consists essentially in the union of two sexual cells, or gametes, of which the female egg-cell is contained in the so-called "ovule" in the "ovary" of the flower, and the male sperm-cell in the pollen grain.

As a rule it is only possible to bring such experiments to a successful issue when working with closely related species or varieties. The flower of one kind of orchid, for example, may perhaps be fertilized by the pollen of a different orchid, but the pollen of such a plant as a lily would probably not have the slightest effect upon it.

The first observer to throw a clear light upon the meaning of the remarkable results obtained by hybridization was Gregor Johann Mendel, a native of Austrian Silesia, born in 1822, whose work has recently attracted so much

attention. As Abbot of Brünn, he was the happy possessor of a garden, and presumably also of that peace and quiet which are so essential to intellectual work. He was not content with merely casual experiments in hybridization. In the seclusion of his cloister he had time to think about what he was doing, and he attacked the problem in the true scientific spirit. Unfortunately for science, however, his seclusion was a little too complete. He was content to publish his results in 1865 and 1869 in the proceedings of a local natural history society, where they remained buried and almost unnoticed for more than thirty years. Thus, by the irony of fate, our own illustrious countryman, Charles Darwin, the hundredth anniversary of whose birth we celebrate this year, never heard of those remarkable discoveries which bid fair to solve some of the problems in which he himself was so deeply interested.

In order to gain an insight into the nature of Mendel's work, we cannot do better than turn to his original memoir, entitled "Experiments in Plant Hybridization," of which an excellent translation has been published by Professor Bateson, the leading exponent of what is now termed Mendelism in this country. Even fifty years ago, experiments in hybridization were, as we have already seen, no new thing. Mendel had many predecessors in this line of research, but it was reserved for him to introduce exact statistical methods into the work, and it is to these methods that he owed his success. It was already known that hybridization, or the crossing of distinct species and varieties, might produce and very often did produce several distinct types of offspring from the same parents. Mendel was not content with this knowledge: he proceeded by numerous and often repeated experiments, extending over several years, to classify the offspring produced by hybridization, to follow out their descendants from generation to generation, and above all to find out the exact numerical proportions in which the different types appeared in successive generations. It was the discovery of these proportions that furnished the clue to the mystery.

Mendel found the material which he required for his experiments chiefly in the numerous garden varieties of the common edible pea. How these varieties first originated we do not know. Probably they arose as sudden and apparently spontaneous variations, or as Professor Hugo de Vries terms them, *mutations*. No less than twenty-two such varieties were selected for experiment.

The next thing he did was to select certain differentiating characters upon which to concentrate his attention, and this is a very important point. Of course, all the varieties agreed with one another in most of their characters, in other words, they were all edible peas exhibiting the specific characters of the plant known to botanists as *Pisum sativum*, but they differed in numerous minor features. Of these differentiating characters Mendel selected seven for the purposes of his experiment, amongst which I need mention only two: (1) the form of the ripe seed, which, roughly speaking, may be either round and smooth or angular and wrinkled; and (2) the difference in colour of the contents of the seeds or cotyledons, which may be either yellow or green.

The two differentiating characters of each pair were artificially united by cross-fertilization, the flowers of a round-seeded pea being fertilized by the pollen of a wrinkled-seeded pea, those of a green-seeded pea by the pollen of a yellow-seeded pea, and so on.

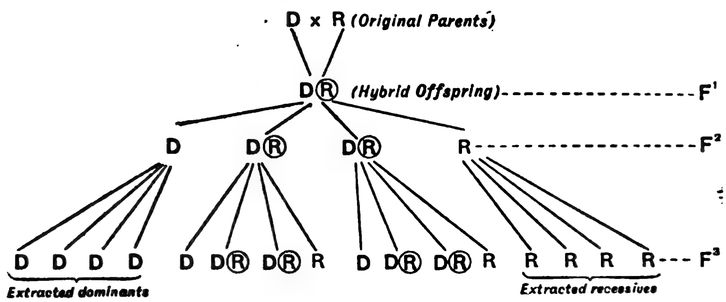
In this way a number of hybrid plants, represented in the first instance by seeds, were obtained, and the curious fact was observed, that each hybrid closely resembled one of the two parents, instead of being, as is frequently the case in other hybrids, intermediate in character between them. Further experiments with the offspring of the hybrids, however, showed that, although only one of the two contrasted characters manifested itself in the hybrid, the other was there also in a latent or dormant condition, and appeared again in subsequent generations. The character which appears in the hybrid is said to be *dominant*, while that which is suppressed is said to be *recessive*. In the case of these peas, then, one character was always dominant over the other in the hybrid, and, moreover, it was always the same character, and it did not matter whether it was derived from the male or from the female parent. Thus the round form of seed is dominant over the wrinkled, the yellow colour of the seed contents over the green, and so on.

Having obtained the hybrids, the next step was to follow the history of the offspring throughout successive generations. For this purpose the flowers of the plants raised from the hybrid seeds were allowed to fertilize themselves with their own pollen, no further crossing being permitted. The seeds thus obtained were now again apparently of two kinds, re-

sembling the two original parent forms from which the hybrid was produced. Moreover, these two kinds occurred in definite proportion, three of the dominant to one of the recessive—three round seeds to one wrinkled, three yellow to one green, and so on. Of course, these proportions are only averages, and in order to eliminate errors of chance, large numbers of observations must be made—the greater the number the more reliable the result. To take an actual example from Mendel's work, 7,324 seeds were obtained in the second trial year from the hybrids between round and wrinkled. Of this number, 5,474 were found to be round, and 1,850 wrinkled—showing the ratio of 2·96 to 1. Again, out of 8,023 seeds produced by the hybrids between green and yellow, 6,022 were yellow and 2,001 green, the ratio being 3·01 to 1. These experiments have often been repeated during recent years, and it is found that the average ratio of three to one is always maintained.

The significance of this proportion is not at first sight obvious. It is necessary to continue the experiment for at least another generation in order to gain further insight into the matter. We have as the result of the self-fertilization of our hybrids apparently only two kinds of seeds or plants, which we may call D, showing the dominant character, and R, showing the recessive character, in the proportion of 3 D to 1 R. If these plants are again cultivated and allowed to fertilise themselves we find that every one of the R's breeds true, and no matter how many generations we raise they will always remain of the recessive type. These are now called extracted recessives. When, however, we cultivate the plants showing the dominant character in the same way we soon find that though similar externally they are not in reality all alike, for one-third of them will yield nothing but D's, while the remaining two-thirds will yield D's and R's in the same proportions of 3 to 1 as the original hybrid. Moreover, the D's obtained from the one-third will continue to breed true from generation to generation, and do what we will we can never get an R out of them again. They are called extracted dominants.

It is obvious, then, from these experiments that the apparent D's are not all true D's, but that two-thirds of them contain the recessive character in a latent or dormant condition, and are, therefore, still hybrid in composition. If we indicate those which we can thus prove by breeding to contain the latent character by the letters D (R), we can sum the whole story up in the following simple diagram :—



Thus we see that from generation to generation of the offspring of the hybrid there goes on a constant sorting out into three categories, the two original parental types and the hybrid form being always produced in definite proportions. If we assume that each kind produces on an average an equal number of offspring, we shall see from the diagram that in the course of a few generations of undisturbed reproduction by far the greater number of the plants will have finally reverted, in equal proportions, to one or other of the original types, but a certain number will always remain in the hybrid condition and will continue to split up as before in the well-known Mendelian proportions.

We see, then, from Mendel's experiments, that in the case of peas, where one of the two contrasted characters is dominant over the other, the offspring of the first hybrid appear in the proportion of three apparent dominants to one recessive, but that further analysis shews that the real proportion is

1 D : 2 D (R) : 1 R.

This proportion has since been observed not only in peas but in a large number of other cases, including animals as well as plants. It is evidently a phenomenon of very common occurrence, though we cannot as yet say that it occurs universally whenever two forms with

contrasted characters are crossed. Moreover, as we have already noticed, the phenomenon of dominance is not always shewn, and the hybrid may exhibit a character intermediate between those of the two parents or different from either. The occurrence of the Mendelian proportions, however, is sufficiently frequent to demand explanation, and this explanation we must now seek.

Suppose we take a large number of black and white counters, all alike in shape and size, and after shaking them up thoroughly in a bag, draw them out two at a time without looking. Each pair that we draw out may consist of two whites, two blacks, or a black and white. If we draw out a sufficiently large number of pairs entirely at random in this way and then count them, we shall find that they occur in the proportion

1 BB, 2 BW, 1 WW,

or one all black, two black and white, and one all white, this being, of course, only what is to be expected in accordance with the mathematical law of probability. This is also the same as the Mendelian proportion, and at once suggests that the latter may, perhaps, be explained in a similar way as the result of random union of characters in accordance with the laws of chance.

We know that each individual plant or animal produced by sexual reproduction is formed by the union of two germ-cells, or gametes, a male and a female. Now these gametes are formed in very large numbers in the parent organism, and if we suppose that each one, whether male or female, contains only one of the two contrasted characters with which we are experimenting, and if we further suppose that they unite at random, male with female, then in accordance with the law of chance we should expect to get in the offspring the proportion, of one with the one character, two with both characters and one with the other character, exactly as Mendel found in his experiments. There seems to be no other possible explanation of the Mendelian phenomena.

The conclusions to be drawn from these results are of fundamental importance. In the first place, we learn that small individual characters may be separately represented in the germ-cells and separately transmitted from parent to offspring. This indicates that the entire organism may be built up of a number of unit characters, and if we can once establish the general occurrence of such unit characters we shall have taken a long stride towards the understanding of the laws of heredity.

In the second place, we may conclude from these experiments that, as regards the unit characters with which we are dealing, we have a complete segregation amongst the germ-cells or gametes, each of which carries only one of each pair of contrasted characters (technically termed allelomorphs), and in this respect it makes no difference whether the germ-cell be male or female. Thus we arrive at what is sometimes termed the doctrine of the purity of the gametes—purity, that is to say, with regard to each character of any such contrasted pair and without reference to the other innumerable characters which must be represented in the germ-cells in order that the whole complex structure of the organism may be developed from them.

Of course, it is extremely improbable that any two varieties which are united in the formation of a hybrid will differ from one another only as regards one pair of contrasted characters. There will almost certainly be more than one such difference between them, and our experiments will be complicated accordingly.

I now propose to give you two examples of a class of practical problems which have been solved by the application of Mendelian principles.

The first case I borrow from the Reports to the Evolution Committee of the Royal Society, the second arises directly out of Mendel's own work. Some of you may be acquainted with a particular breed of fowl known as the blue Andalusian. It has long been known that this kind of fowl cannot be made to breed true. Some of the offspring will be white and others white with black splashes, the remainder being like the parents. It has been shown, moreover, that the three kinds of chicken occur in definite proportions, a quarter being black, a half blue, and a quarter black and white. Here we have the familiar Mendelian proportions 1 : 2 : 1, suggesting that the blue Andalusian is really a hybrid, and that the so-called "wasters" are the parent forms. It is easy to prove that this is the case, for if the two kinds of wasters are mated we invariably get the blue Andalusian again. The old idea of the so-called practical breeder would have been to go on destroying the wasters and carefully selecting the blues in order to maintain the "purity of the breed." We now know, however, that there is no such thing as a pure blue Andalusian breed: the

blue is really a hybrid, and you can get more blues by mating the wasters than by breeding from the blues themselves. This case is also theoretically interesting as affording an example of a hybrid which differs in character from either of the parent forms.

The second example is one which shows us how, under certain circumstances, we can obtain a hybrid exhibiting an entirely new combination of characters, which in spite of its hybrid nature will continue to breed true.

Suppose a gardener had only two kinds of peas, one with round green seeds, and the other with wrinkled yellow seeds, and that, as usual, he wanted something that he hadn't got, say peas with wrinkled green seeds. Mendel has shown us how he may get what he desires, both surely and speedily, from the material already in his possession.

The necessary procedure will be evident from the following scheme :—

Let R = round, W = wrinkled, Y = yellow, and G = green. We know from previous experiments that R is dominant to W, and Y to G.

R G crossed with W Y, gives the hybrid, R (G) (W) Y, which owing to the dominance of R and Y will appear in the form of round yellow seeds. That is not what our gardener wants, and if he knew no better he would naturally be much disappointed with the result. If, however, the hybrids be allowed to fertilize themselves and reproduce, then their offspring will appear in the proportions :—

9 R Y : 3 R G : 3 W Y : 1 W G.

This is a case of what is termed di-hybridism, in which two pairs of contrasted characters, or allelomorphs, are concerned. The proportion 9 : 3 : 3 : 1 exhibited in this case is partly due to the phenomenon of dominance, and will be readily understood from the accompanying Table :—

Germ cells → ↓	R Y	R G	W Y	W G
R Y	R Y R Y	R (G) R Y	(W) Y R Y	(W) (G) R Y
R G	R Y R (G)	R G R G	(W) Y R (G)	(W) G R G
W Y	R Y (W) Y	R (G) (W) Y	W Y W Y	W (G) W Y
W G	R Y (W) (G)	R G (W) G	W Y W (G)	W G W G

The constitution of the hybrid is R G W Y. Each of its germ-cells or gametes contains one character, and one only, from each contrasted pair. It may, therefore, contain R + Y, R + G, W + Y, or W + G. These different kinds of germ-cells will occur on the average in equal numbers, and on self-fertilization (R G W Y × R G W Y) they will unite in pairs at random. The possible ways in which such union may take place are shown in the Table, and if allowance be made for the phenomenon of dominance, in accordance with which G disappears from view whenever it meets Y, and W whenever it meets R (as indicated by the brackets in the Table), we get the apparent proportion of 9 round yellow seeds, 3 round green seeds, 3 wrinkled yellow seeds, and one wrinkled green seed. The number of wrinkled green seeds will be small at first, but they will breed true, containing as they do only the extracted recessive characters, for if a dominant character were present it would necessarily show itself.

Thus we see that one way of producing new forms of plants and animals is by the artificial combination of desirable characters which already exist in different varieties. These elementary or unit characters can be brought together by the process of hybridization, and new organisms produced in much the same way as the chemist is able to produce new compounds by analysis and synthesis from other substances.

Probably no man has made more successful use of the process of hybridization in the production of new and valuable forms of plant-life than Luther Burbank, at his celebrated Californian nurseries. Burbank himself is unfortunately not a writer, and for a scientific account of his work we are indebted to the distinguished botanist Hugo de Vries. In his delightful little book on "Plant Breeding," Professor de Vries describes what he himself saw and heard during his visits to Mr. Burbank's farms. It is not necessary for me to enter into details with regard to the marvellous results which Mr. Burbank has obtained. Some idea of their commercial value may be formed from the fact that special companies have been formed for the propagation and sale of some of these wonderful hybrids. White blackberries, stoneless prunes, "plumcots," and thornless cacti are only some amongst the many novelties which he has produced by crossing different varieties by hybridization and thus combining two or more desirable qualities in one plant.

Take, for instance, the case of the stoneless prune. It had somehow or other come to the knowledge of Mr. Burbank that about 200 years ago there existed in France a plum known as the "Prune sans noyau." He succeeded in obtaining specimens of this fruit, but it proved to be of little or no commercial value owing to its poor quality. Its one valuable feature was its stonelessness, and Burbank set to work to transfer this character, by hybridization, to a variety of good quality. He succeeded, and there appears to be no reason why the stoneless character should not be similarly implanted upon all the different varieties of plums now in cultivation.

Similarly the "plumcots" are hybrids between plums and apricots, which Professor de Vries speaks of as "most delicious and beautiful fruits."

It must be admitted that Burbank's work is practical rather than scientific. He apparently pays no attention to the law of Mendel in his operations, and just goes on hybridizing until he gets what he wants. In this process enormous numbers of plants which do not fulfil his requirements have to be destroyed for every one that is worth preserving.

He is not necessarily concerned with the production of pure breeds; of forms, that is to say, which will breed true from seed, or in other words, of forms which will hand on their desirable qualities to future generations by heredity. This does not matter in the case of fruit trees and other plants which are propagated by buds independently of sexual reproduction. As a general rule, a fruit tree cannot be relied upon to come true from seed, the characters which it has received from different ancestors not being permanently combined, but separating out and undergoing fresh combinations in the sexual process, probably in accordance with Mendelian principles. The seedlings will therefore be "degenerate," as horticulturists say, and will no longer exhibit those valuable qualities which depend upon the confluence in one individual of several lines of ancestry.

The operations controlled so successfully by Luther Burbank are to a certain extent similar to those which take place in a state of nature. He produces a great variety of new forms and from these he selects what he requires. The process results in enormous waste, but so also does the process of natural selection. Under natural conditions waste of life is a necessary condition of progress.

The majority of Burbank's productions however, could not survive in a state of nature at all; they are essentially artificial and have to be artificially propagated by means of buds or cuttings. In this respect they are quite different from the pure races which it is possible to produce by hybridization carried out in accordance with Mendelian principles, in which new and permanent combinations of unit characters, capable of being transmitted by heredity, are effected.

Professor Bateson, Professor Biffen, Mr. Hurst and others have lately done much to demonstrate the possibilities of progress in this direction, and the value which the application of the Mendelian principles of heredity must have from the economic point of view. We know now that such cereals as wheat and barley obey the Mendelian laws of hybridization as regards various important characters. So also do horses as regards the colour of their coats, and human beings as regards the colour of their eyes, and in certain other respects. In short, it appears certain that Mendelian principles have a very general application, and the economic value of the knowledge of such principles in the case of organisms which are only propagated sexually must be enormous.

It is true that Professor Hugo de Vries considers that in the case of cereals it is quite unnecessary to resort to hybridization in order to effect improvements. He considers that all that is necessary is to select individual plants exhibiting the desired characteristics from amongst the numerous varieties which occur naturally, and to propagate by seed from them.

Speaking of the experiments in plant breeding which have been carried on with such remarkable success for many years past at the Swedish Experimental Farm at Svalof, he remarks:—

"They confirm the fact that the ordinary cultivated varieties of cereals are by no means pure, but must be considered as mixtures of well-defined types. Moreover, they show that these types are far more numerous than was previously supposed, and include hundreds of forms within each of the now prevailing sorts. . . . . The range of variability disclosed by these new studies is simply so wide that it affords all the required material for almost all the selections desirable at present, and will, no doubt, continue to be an inexhaustible source of improvements for a long succession of years. They are founded on the principle of single selections, and the range of application of this method is proved to be so extensive as to make all ideas of repeated or continuous selection

simply superfluous. It is even so rich in its productiveness that there is scarcely any room left for other methods of improvement, and especially should all endeavours of winning ameliorated varieties of cereals by means of hybridization simply be left out of consideration, as compared with the immense number of more easily produced novelties which this method affords."—"Plant Breeding," p. 50.

No doubt much can be done in this way, but it is obviously only applicable in the case of organisms which exhibit a very large number of naturally occurring true-breeding varieties or mutations, and such organisms are, I believe, comparatively uncommon. Moreover, it is difficult to believe that even in the case of cereals the possibilities of improvement can be exhausted by simple selection. Indeed Professor Biffen's work indicates a much wider prospect, for he has shown, for example, that susceptibility and insusceptibility to that destructive disease in wheat, known as "rust," behave as Mendelian characters, and that it is possible by a very simple process of hybridization to confer immunity from this disease upon naturally susceptible varieties.

It may be admitted that if you want a suit of clothes it is easier and more convenient to go into a slop shop and trust to chance for a ready-made article which will "do," but the results are hardly likely to be as satisfactory as if you chose your own cloth and then had it made up to suit your own requirements. Nature certainly supplies us with a fine choice of ready-made articles, but you may happen to want something that is not in the shop, and then it is a great thing to be able to select the best possible materials and have what you want made to order.

The great lesson which we have to learn from experiments in the breeding of plants and animals is that the living organism is a composite structure built up of a vast number of minute characters, many of which at any rate are separately represented in the germ-cells from which the organism develops. How this representation is effected we do not at present know, but the evidence points to the existence, probably in the chromative substance of the germ-cells, of ultra-microscopic material particles which are, in some way, responsible for the transmission of such characters from generation to generation. Moreover, it appears that each particular character of this kind may be either represented or not represented in any one germ-cell, and that in the process of shuffling which takes place in sexual reproduction individual characters may be added or subtracted, or substituted one for another, without affecting the stability of the organism as a whole. The practical importance of these results lies in the fact that it is possible by controlling the mating of male and female, and thus bringing about new combinations of selected characters, to control at the same time the course of evolution itself, and direct the stream of life in chosen channels.

Man's conquest of nature, which began with the control of inanimate forces and gradually spread over the animal and vegetable kingdoms, is now penetrating to the citadel of life itself. The citadel, however, has not yet capitulated. We have still much to learn; above all we want to know the cause of those sudden variations or mutations which occur in nature. We are already able to take advantage of such mutations for the improvement of plants and animals, but we cannot make our own building material; we do not know how such characters arise, and we cannot produce them ourselves.

It is easy, of course, to modify artificially the development of individuals, for individual development depends very largely upon the conditions of the environment,* but we have not yet learned how to render such modifications inheritable. In other words, our artificial modifications of the body seem to have no effect upon the constitution of the germ-cells.

This of course is the old problem of the inheritance of acquired characters, and from the nature of the case it appears extremely doubtful whether we shall ever be able to find a practical solution of this problem. Many people maintain that acquired characters cannot be transmitted at all; but it may be merely a question of the degree in which they are transmitted, and of the number of generations which it takes for a character acquired by the body to induce a corresponding impression upon the germ-cells.

The germ-cells are eminently conservative bodies, and thus it happens that while the individual organism is more or less susceptible to every change of environment, the race to which it belongs changes but slowly. This conservatism is itself doubtless an extremely valuable character, just as it is in human politics, where there is something to

* It has recently been shown, for example, to take an extreme case, that the addition of magnesium salts to the water in which the eggs of a fish (*Fundulus*) are developing will cause a large percentage of them to develop into Cyclopean monsters, with a single large median eye in place of the normal pair.

be said even for an hereditary House of Lords. It has probably arisen through natural selection, for while it is an advantage to the individual to be able to adapt itself to new conditions which may be as evanescent as its own brief life, it is still more important that the race to which the individual belongs should not be permanently influenced by every wind that blows, but should maintain an average adaptation to an average environment. Moreover, individuals which inherited accidental deformities or mutilations would be at a serious disadvantage in the struggle for existence, and thus the power of inheriting acquired characters must itself tend to be eliminated.

Even, however, if we are unable to bring about the hereditary transmission of acquired characters, there still remains a wide field open to us. We can not only select and cultivate favourable varieties with which nature provides us, but which might not, perhaps, survive in a state of nature; but we can produce at will new combinations of selected characters, and therefore actual new forms of life which might never have occurred in a state of nature at all.

The CHAIRMAN (Professor J. M. Thomson) said that on the occasion of special lectures, such as the Aldred Lecture, no discussion was invited, and it was therefore his duty, and at the same time his pleasure, to tender the hearty thanks of the meeting to Dr. Dendy for his most interesting lecture, though he regretted that someone more conversant with the special branch of science which had been so ably dealt with had not been able to occupy the chair on the present occasion. Sir William Ramsay had delivered a most brilliant lecture in the autumn of 1907, and they had heard that evening a second discourse of equally high merit. He was sure they might expect that the Aldred Lectures would in the future be just as brilliant and instructive.

EARNINGS AND HOURS OF LABOUR IN THE TEXTILE TRADES.

In 1906 an inquiry was instituted by the Board of Trade into earnings and hours of labour in all trades, and the first instalment of this inquiry, bearing on the earnings and hours of labour in the textile trades, has just been issued. A similar but less complete inquiry was carried out in 1886, and the principal object of the present one appears to be to show the movement in the twenty years 1886-1906. Unfortunately for the purposes of comparison, 1886 was a year of extreme depression, while 1906 was a year of exceptional prosperity. Sir H. Llewellyn Smith has sought to meet the difficulty by taking the quinquennial periods 1884-8, and 1904-8 to correct the results of the single year, but even this larger comparison is restricted to some extent by the fact that the earlier period covered four exceptionally bad years while the second period contained only one very bad year and two good ones including the exceptionally good one of 1907. The inquiry covers more ground than that of 1886 since in the earlier inquiry the principal object was to obtain the rates of wages for a full time week, whereas in the present one, to quote Mr. Askwith, "the main consideration was the ascertainment of the actual earnings of each individual irrespective of the hours worked."

Perhaps the most striking fact brought out by this return is the comparative decline in the numbers employed in the textile trades. Taking adults and half-timers the total in 1885 was 988,436, and in 1904—the latest date for which the figures are available—1,010,506. In the woollen and the worsted, the linen and the silk trades there were large decreases in all; having regard to the growth of population, there has been a serious falling off, with the exception of cotton in which the numbers increased from 479,073 to 514,204, and hosiery where they nearly doubled—from 19,374 to 36,305—owing to the extension of the factory system of manufacture in that branch, the present returns relating only to factories. It is a common statement that half-timers have greatly increased in recent years, but the present inquiry shows that between 1885 and 1904 they actually fell from 91,651 to 31,744, and in the cotton trade from 49,992 to 17,651.

In comparing the general average for full time workers deduced from the returns of 1886 and 1906 it must be remembered that many changes have taken place during the twenty years, and that the two years were very different in character. Textile processes have been considerably improved, new processes have been introduced, and the classes of goods manufactured have changed with fashion and standard of living. For all the textile industries combined the percentage increase in average full time earnings is shown to be 16 per cent. for men and 18 per cent. for women. The advance in the case of men was greatest in the cotton industry, in which it amounted to 22 per cent., in the case of women the increase was greatest in the jute industry, viz., 40 per cent.; in the cotton industry it was 24 per cent.; in the linen industry 21 per cent. The figures show very wide variations. In the cotton trade, for instance, mule spinners on full time average 41s. 2d. a week in all centres; in Bolton they rise to 45s. 9d.; in Manchester to 47s.; and in Liverpool to 47s. 6d. The earnings of weavers again range from 15s. 4d. for three-loom female weavers in Manchester, to 33s. 6d. for six-loom male weavers in Burnley. The average earnings of some of the men employed in the lace industry is noticeable. Of the lace-makers in the levers branch 33 per cent. earned £3 per week or more, and more than 80 per cent. earned £2 per

week or more. In the curtain and plain net branches the majority in both cases earned between 30s. and 50s. per week, the percentages below or above these amounts being comparatively small. The average earnings of the whole 8,360 workpeople in this industry covered by the returns was 21s. 11d.

In the period under review the maximum number of hours during which work can be carried on in the textile factories by women, young persons, or children was lowered from 56½ to 55½ on 1st of January, 1902, a reduction in the working time of nearly 2 per cent. Throughout the cotton, woollen and worsted, and carpet industries the regular working hours are practically identical with the maximum limit for textile factories. The average annual earnings of the workers were highest in the lace section, £54 10s., cotton coming next with £48. The inquiry shows that during the twenty years the position of the textile workers was materially improved both as regards wages and hours of labour. A comparison, so far as it is possible—and at best it must be very imperfect—between the earnings of British and German textile workers as obtained from this report, and that issued by the Board of Trade last year on Germany, shows that on the whole the German worker earns the larger wages.

BELGIAN HORSE BREEDING.

The horse fairs that are held in the course of the year throughout Belgium are now largely attended by foreigners, especially by Germans, who purchase, it is said, from 20,000 to 25,000 horses annually. In 1906, 53,500 horses were reported sold at an average price of £33. During the year 1907, 53,000 horses were imported into Belgium, principally from England, France, Holland, and Germany. It is estimated that there are at present some 275,000 horses in Belgium, and horse breeding has, thanks to judicious fostering on the part of the Government, become an important and remunerative industry. In 1907, 27,000 horses valued at about £1,500,000 were exported. The American Consul at Liége states that at the last horse show held in Brussels under the auspices of the Society "Le Cheval de Trait Belge," a remarkably interesting collection of animals was brought together, among which were found some of the best specimens of the equine race that are produced in Belgium. The exhibit of working horses at this show out-rivalled anything of the kind that had taken place in Belgium during recent years, and showed a marked advance over all previous exhibitions of this kind. Belgian horses may be generally divided into two distinct groups, the Flemish breed and what is known as the Ardennes horse. To the first group belong the large massive working horses in general use throughout the country, and found in especially large numbers in Flanders. These animals are largely sought after, both in the country itself and abroad. Under this class may also be included the Brabançon horse, which in appearance is almost identical with the Flemish animal, being equally large and massive. The horses of Hainaut, the Hesbaye, and the province of Namur, although belonging to the group of heavy working horses, represent in a measure the transition from the Flemish breed to that which inhabits the Condroz and Ardennes districts. Much smaller than the smallest Flemish horse, the Ardennes horse is robust, long necked, and broad shouldered; he resists fatigue and supports privations better than the horses of other races. Such at least are the characteristics of the pure blooded Ardennes horse, but this breed of late years, owing to its having been continually crossed, with a view of increasing the size of the animals, can scarcely be said to exist in its pure state any longer, and it is said to be somewhat difficult to find a really pure blooded Ardennes horse at the present time. The Condroz horse very closely resembles that of the Ardennes. Generally speaking the Belgian horse is being continually improved, and the Government authorities liberally encourage all improvement of the equine races of the country, placing their best bred stallions at the disposition of private breeders. Apart from the question of locality, the Belgian breeders are keenly alive to the importance of keeping in Belgium the best specimens of breeding stallions. These superior breeding animals are no longer put up for sale, as those who own them find it much more to their advantage to retain them, thereby giving the Belgian breeders a decided advantage over breeders of Belgian horses in other countries. As an illustration of the price of one of these high-class stallions, it may be mentioned that the owner of the winner of the world's championship at the Vincennes Exposition of 1900 refused an offer of £1,600 for the animal. Belgium has not been alone in her efforts to develop and improve the breed of heavy draft horses, as the French, Germans, and English have all made decided advances in the improvement of breeds of their Percherons, Boullonais, shires, and Clydesdales, as well as the Belgian breeds. The fact, however, that the Belgian horse is becoming more and more appreciated and sought after abroad can well be a matter of congratulation for the breeders in Belgium in their successful efforts to improve the race. The success of the Belgian horse in Germany, especially in the Rhine provinces, has ensured its adoption in other countries, and it is believed that before long this race will be universally preferred to all other heavy draft races; in France, an official stud book of Belgian horses has existed for the past two years. In Holland, this race is bred to the exclusion of nearly all others in the districts of Zeeland and Limbourg. In Italy, Hungary, Croatia, Russia, Denmark, &c., the Belgian horse is extensively purchased. In the United States, it has not met with the high favour that it has enjoyed in other countries. There among many

animals of this class, the Percheron has taken the lead, followed by the shires and Clydesdales; but during the last few years attention has been turned to the Belgian horse, and its popularity is on the increase.

THE MINERAL SPRINGS OF PALESTINE.

The Holy Land abounds in mineral springs, as for instance at Gadara (east of the Sea of Galilee), and at Hamamim Suliemani (east of the Dead Sea). Their temperature ranges between 80° and 140° Fahrenheit. Intensely saline springs exist along the banks of the Dead Sea, all cathartic and useful in the case of liver and other diseases. None of these waters are bottled or exported except as curiosities by tourists. Especially celebrated are the hot springs at Tiberias, which, even since the Roman occupation, have been renowned for their curative powers and in bygone ages were compared to the famous waters of Baia. According to the American Consul at Beirout, the present baths at Tiberias were built by Ibrahim Pasha in 1833 during the Egyptian invasion. Additions were made in 1890 by the Turkish Government, but the accommodation is inferior and lacks cleanliness. The temperature of these springs is about 143° Fahrenheit, and the waters contain sulphur, chloride of magnesium, and iron. They are in many respects similar to those of Carlsbad. The hot springs of Tiberias are largely frequented by natives from all parts of Syria, and are reputed to cure chronic rheumatism and various skin diseases. In 1887, Dr. Schumacher, of Haifa, was asked by the Turkish Government to plan suitable modern baths, but the project was never carried out, owing to the fact that, according to a firman, the baths could never be let for a longer period than two years, and consequently no responsible person could be found to take them over and place them under efficient management. All efforts by natives and foreigners to change the terms of the lease failed, the Government considering that the baths in their present state were quite sufficient for their purpose At present the revenues of the establishment accrue to Tiberias, while the annual rent, amounting to some £500, flows into the national exchequer. In Roman times the springs were called Ammaus. Pliny extolled their excellent properties. Roman villas, temples and baths, surrounded, and Herod's acropolis crowned, the heights near the Thermal baths. Under European or American management, with the expenditure of about £10,000, the establishment might, it is said, become a source of wealth to those concerned. The season lasts from February to May. In Galilee the climate is delightful in the spring, and according to the Consul, a resort offering such baths and such historical associations, would seem to have a bright future.

HOME INDUSTRIES.

The Budget and Home Industries.—Not since the great Budgets of Peel and Gladstone, which revolutionised the fiscal system of the country, have so many home industries been affected as by the Budget proposals now before Parliament. The interests concerned may be divided into three classes. (1) those which see their way to transfer the added burden to other shoulders, as, for instance, the brewers and distillers, and tobacco manufacturers: (2) those which hope to divert consumption from the threatened article to another, as from petrol to petroleum in the case of the motor industry; and (3) those which have to face the impost without hope of relief, as with the hospitals. Not only will "the Trade" shift the additional taxation from itself to the public; it is making large immediate profits. According to the Excise receipts, 2,000,000 gallons of spirits in excess of the average were taken out of bond by the Trade in April in anticipation of the increase of duty. The Treasury receipts show the extraordinary increase from £2,314,000 received in April, 1908, to £3,408,000 received last month, an increase of no less than £1,094,000. It is estimated that this "intelligent anticipation of events" will give the Trade a net gain of about £350,000, since each gallon escapes the 3s. 9d. additional tax. But this, of course, is only a part of the golden harvest being reaped just now by brewers and distillers: for they are charging the public a penny a glass extra on brandy, whiskey, &c., and proportionately on beer. What this means will be understood when it is remembered that a gallon of proof spirit, after being broken down, makes 150 glasses, so that the wholesale and retail traders between them will secure from the public 12s. 6d. a gallon, on 1,000,000 gallons more than they would have got if there had been no increase in the duty. In proposing to tax petrol, the Chancellor of the Exchequer encourages inventors to discover a suitable engine for self-propelled vehicles capable of running on heavy oils, with a high flash point. Petroleum engines of this type which work well have already been employed with complete success for marine purposes, and also as stationary engines on land, and although there are many difficulties in the way of using heavy oils in high speed engines of the ordinary construction, as applied to motors, it may be expected that the duty on petrol about to be imposed will, sooner or later, lead to increased use of petroleum for motor purposes. It is feared that the proposed tax of 1½d. per gallon upon petrol for use in commercial motor vehicles, which is equal to an increase of 25 per cent. on the fuel bill, will seriously handicap the country's internal transport. The hospitals unhappily come under the third class indicated above. They have already received letters from wholesale druggists intimating that owing to the advance in duty on spirits they will be compelled to charge increased prices, and an advance of 6s. 6d. a gallon on rectified spirits is spoken of, and of 10d. a pound on ether. It is estimated that in the

case of the London Hospital alone the increase in the cost of rectified spirits will mean nearly £100 per annum, and in ether of close upon £120. Taking the Metropolitan hospitals as a whole, it is expected that the Budget proposals, if they become law, will cause an increase of several thousand pounds per annum in their medicine bills.

The Tobacco Industry.—The imposition of an additional 8d. per lb. duty on tobacco took the Trade completely by surprise, and has seriously disorganised it. So far from expecting any such increase the Trade were not without hope that what is called the "war surtax" of 4d. per lb. would be removed. There is no precedent for raising the duty on unmanufactured tobacco so much as 8d. per lb. The 1900 addition, regarded as purely a war tax, was only 4d. per lb., bringing the duty up to 3s. per lb. On that occasion the trade refrained, owing no doubt largely to the inherent difficulties of doing so, from advancing prices to the consumer, but on the present occasion the consumer will have to bear the burden. The Trade is already readjusting prices. The working man's tobacco at 3d. per ounce, a feature of the trade for half a century or more, will disappear, and on tobacco and weight cigarettes the entire duty will be recovered by advancing the price to the consumer by a halfpenny per ounce. The change, as it affects cigars, is expected to be not in price but in size, which will be reduced, but the prices already fixed in the wholesale trade are mainly provisional. The alterations, as indicated above, do not take into account the great advance in the cost of raw material, and it is urged that advantage should be taken of this opportunity to advance prices to the consumer to a degree commensurate not only with the increase of duty but with the advance in the cost of raw material. Manufacturers expect that about a fifth more capital will now be required to carry on the same volume of business, and it is feared that this will have the effect of concentrating the manufacture of tobacco in the hands of two or three large companies, a tendency that has been very apparent for some years past. The additional cost of tobacco to the consumer must result in diminished consumption, and in the opinion of experts this decrease will be considerable.

The Shipbuilding Industry.—The past winter was the worst in the shipbuilding districts since 1898, and although the amount of new constructional work turned out of the yards, during the quarter ended March last was larger than might have been expected from the general condition of things, it was due, in considerable measure, to the fact that some vessels that, in ordinary circumstances would have been put into the water last year, were delayed, and so fell into the sum of this year's launches. But whilst there is no likelihood of a large accession of activity in the near future in the shipbuilding industry the outlook is improving. A large amount of new tonnage has been booked. The new orders reported as having been placed with the Scotch shipbuilders in 1909 are estimated to amount to a quarter of a million tons, and although they include Admiralty orders under the 1908 programme, the demand is mainly for merchant shipping, a large proportion of it being "tramp" tonnage. It is said, too, that the contracts are not on the long-credit system by which so many shipping co-partneries were brought into being, to the loss of most concerned, and which helped so largely toward the boom in shipbuilding in recent years; but are being entered into by level-headed men with the necessary capital at their back. Their idea seems to be to contract for ships at the present low prices, and to have them built leisurely, so as to be ready for the expected revival of trade next year. The amount of laid-up tonnage has decreased, and is decreasing, and the natural wastage of the world's merchant shipping through wrecking, break-ups, &c., is estimated at about 800,000 tons per annum, but of late so much tonnage has been unable to find remunerative employment that it is difficult to believe that any probable revival in trade will find work for all the new shipping now projected.

Insurance of Live Stock.—The dispute between the farmers and purchasers of live stock as to warranty continues, but it looks as if the farmers will succeed in resisting the demand of the butchers. There seems to be an opening here for insurance companies. Until now the large insurance companies do not seem to have laid themselves out for the business though insurance would appear to afford a solution to the difficulty, and the task of devising a workable scheme ought not to be beyond the ingenuity of the companies. Small local societies for the purpose of insurance have indeed been promoted already in certain districts but it would be much more satisfactory if the business were taken up by leading insurance companies.

Cotton-growing Within the Empire. — At the annual banquet of the British Cotton-growing Association a very encouraging report was given of the work done by the Association in assisting and directing the growth of cotton within the Empire. All are agreed as to the enormous importance of the work undertaken by the Association. Whilst Lancashire is dependent upon the United States to the extent it is at present for the raw material it requires for its cotton industry, it can never be sure that from one cause or another it will not have to face a repetition of the catastrophe of the early sixties, when the civil war in America stopped the supplies of cotton from the South. But it is to be feared that the time is still distant when territories within the Empire will render Lancashire independent of America. The revival of the cotton industry in the West Indies has been of much benefit to the natives in some of the islands, but the total exports remain very small; from Uganda, Nyassaland, and Rhodesia the reports are favourable, but the acreage under cotton cultivation grows only very slowly; it is from Nigeria that the largest imports may be expected. In 1903 Lagos

exported 500 bales, in 1907 the exports had increased to 9,700, last year the drought caused it to drop to 5,500 bales, but the produce of the first four months of the present year was 8,500 bales. The soil is suitable, the acreage practically unlimited, and labour is to be got at 6d. a day. It may, therefore, be hoped that in course of time Nigeria will supply a considerable proportion of our cotton imports, but it must be many years before the present dependence upon America is visibly diminished. The efforts of the British Cotton-growing Association to increase the growth of cotton within the British Empire deserve the thanks of the whole community, and it is pleasant to note how warmly their efforts are being seconded by the Colonial Office.

CORRESPONDENCE.

WEEVILS.

The *Journal* of the Royal Society of Arts of the 19th March, 1909, on p. 383, contains a paragraph referring to "Weevils," in reference to Mr. Frederick Nöel-Paton's article in the *Journal* of the 12th March, 1909, wherein the latter referred to investigations made which showed "that wheat uncontaminated with weevil before the experiment lost 26 per cent. of its weight in three months, after the introduction of the insects, while 65 per cent. of the kernels were at the end of that time found to be weevilled," all resulting in enormous damage and loss to all parties growing wheat, and as a natural result, retarding the progress of the country of production.

The following custom I have known to exist in Jamaica for over 20 years:—

Wholesale dealers in flour-meals, handling large quantities, or retailers who retail small quantities, handling wheat-flour, corn-meal, oat-meal, corn and such like, invariably have suspended near such stores a dried lobster. This is bought for a few pence from the fisher-folk, and is straightway suspended in proximity of these goods, say within 20 feet or so; and its presence effectually stops weevils from attacking such goods.

After reading the *Journal* article referred to it naturally came to my mind that perhaps the above is unknown outside Jamaica, and it is worthy of being brought before the Royal Society of Arts.

A. C. Bancroft.

Stokes Hall, Plantain Garden River,
St. Thomas ye East, Jamaica.
17 April, 1909.

[It is difficult to understand the reason for the practice described in Mr. Bancroft's letter, but the statement is given on his authority.—Ed.]

DEW-PONDS.

Under the above heading an article appears in the *Journal* of May 7th. This article is practically a reprint of a letter, signed "E. A. M.," which appeared in "Nature," on the 22nd April.

"E. A. M." in that letter attempted to controvert the views I expressed in my paper at the Royal Society of Arts on March 3rd.

I regret to say that the Editor of "Nature," could not spare the space to print my reply to "E. A. M.s" letter, but he forwarded my reply to "E. A. M.," for his remarks. "E. A. M.'s" printed criticism of my paper therefore remained unanswered, so far as the public was concerned; but now that his criticisms appear in the Royal Society of Arts *Journal*, another opportunity is afforded me of replying.

In my paper to the Royal Society of Arts, I attempted to explain those natural causes which compel the deposition of aqueous vapour into a dew-pond. So far as I know, the theory of the heat non-conducting properties of straw when used in the foundation of a dew-pond, had not previously been advanced, until my brother and I published "Neolithic Dew-ponds and Cattleways." Though the subject of dew-ponds was occasionally referred to by various writers, prior to the publication of "Neolithic Dew-ponds and Cattleways," I venture to think that it was this work which aroused the general interest of the public within the last few years.

"E. A. M.'s" conclusion that "the dew-pond of the Downs depends for its water chiefly upon rains, and in a much smaller degree on mists and hill fogs, and that dew, *per se*, forms a very inconsiderable factor in the supply," is no doubt in the main correct. The truth of this conclusion may at once be demonstrated by a comparison of the rainfall and the evaporation on the tops of the Downs. According to "Symon's Meteorological Magazine," April, 1909, it is stated that "On the summit of the South Downs the annual rainfall is from 35 to 40 inches; the annual evaporation is certainly not more than 20 inches, and so from rain alone a pond should accumulate a depth of 15 to 20 inches in a year, supposing the bottom is watertight."

Assuming the correctness of this statement, any watertight horse-pond on the tops of the South Downs in England, should year by year accumulate more and more water, until it overflows, even without any advantage which might be derived from a non-conductor heat in its formation.

The main point, however, to which I desired to direct attention in my paper at the Royal Society of Arts, was not so much how to obtain a water supply in this country but rather to show how a water supply might be obtained in a waterless country in the absence of rain, springs, or streams. Reference was made to the dew-ponds in this country, and I stated that "in numerous dew-ponds in this country the dew-point is reached without difficulty." To this remark "E. A. M." says: "Nothing is given in support of this statement, and we may well ask on what evi-

dence it is based. It presumably means that the water itself reaches a temperature which is below the dew-point." "E. A. M." is correct in that presumption, in so far as I am referring to the surface film of water.

The evidence that the dew-point is reached in some ponds in this country, is shown by the example I quoted from Mr. Allcroft's book entitled "Earthworks of England," where he states that from actual experiments "a dew-pond may rise as much as 2 inches in a single foggy night in January, and in five nights rise fully 8 inches. In the early summer the same pond collected 3½ inches of water upon five nights of heavy dew." The dew *per se* can hardly be considered as "a very inconsiderable factor in the supply" in this particular test, and I fail to see how this deposition could have taken place unless the surface of the water afforded a suitable condensing area.

If vegetation were growing above the surface of the water, or if the banks of the pond were covered with grass, the conditions would be altered; but these experiments were carried out by Mr. C. J. Cornish, and I am therefore unable to do more than quote from what has been already published by others.

If the dew was directly deposited on to the surface of the water, "E. A. M." may, I think, be satisfied that the temperature of that surface was below the dew-point, otherwise I cannot imagine that it would have formed a suitable condensing area.

The view expressed by Mr. E. A. Martin in a recent lecture on "Dew-ponds" given at the Royal Geographical Society, is "that dew can be received by a pond on its surface, even while a pond has not yet fallen to the dew-point."

This may be true so far as the temperature of the water below the surface is concerned. It is, however, the surface film of water that is alone involved, and what actually takes place here is not recordable by the readings on a thermometer. Careful scientific research may some day reveal what actually does take place when the aqueous vapour is condensed and when evaporation is in progress. We know in the rough that under given conditions certain results will be obtained, and by a scientific application of the principles, so far as they are known, a water supply may yet, I am confident, be obtained in certain waterless lands.

GEORGE HUBBARD.

112, Fenchurch-street, London, E.C.,
May 11th, 1909.

QUESTIONS AND ANSWERS.

NOTICES TO CORRESPONDENTS.

Readers in search of information which cannot be obtained from the usual sources are invited to make their wants known in the *Journal*, in the hope that they may be assisted in their difficulties by their fellow members.

On all communications must be written the name and address of the sender, not necessarily for publication, but as a guarantee of good faith.

Each question or reply should be written on a separate sheet of paper, and should bear such signature of the writer, and such address as he wishes to appear.

Questions which can be answered from the usual books of reference, will not be printed.

QUESTIONS.

WAX FOR MODELLING PURPOSES.—I have a collection of bas-relief portraits in wax, some of which appear to be of considerable age. Can any member of our Society give me any information as to the earliest use of wax for modelling purposes?—CERA.

PORTLAND CEMENT AND LIME.—Can any member say what effect Portland cement has on lime mortar composed of coral lime or limestone lime? It is believed by some engineers and builders that the addition of Portland cement to lime mortar considerably weakens the composition, and that cement so used is wasted. I believe the addition of cement is beneficial, not only because it strengthens the mortar, but because it reduces the tendency of the growth of vegetation on walls, which in the tropics is very distructive.—J. L. S.

GENERAL NOTES.

HOOPER SCHOLARSHIP.—The Council of the Institute of British Carriage Manufacturers offer for competition the "Hooper" Scholarship of £50, tenable for one year at the Higher Technical Day Class for Road Carriage Building at The Polytechnic Carriage-Building Schools, The Polytechnic Annexe, Balderton-street, Oxford-street, London, W. Forms of application can be obtained by applying to the Secretary of the Institute, 1, Queen Victoria-street, London, E.C., to whom they must be returned on or before the 30th June, 1909.

PHYSICAL DEFECT AND THE WORKMEN'S COMPENSATION ACT.—It often happens, perhaps oftener than not, that an Act of Parliament intended to benefit a particular section of the community, inflicts upon it, or a portion of it, harm rather than benefit. This seems to be the case with the Workmen's Compensation Act. As a result of the working of the measure old and infirm workmen, and others tending that way, or suffering from physical defect, find it impossible to obtain employment. The insurance companies will not insure them, and employers will not take men they cannot insure. Thus the nation is

called upon to support workmen and their dependents whose means of subsistence has been withdrawn, and it is a matter of moment to devise some means to prevent the enforced pauperisation of those who are willing to support themselves and their families but are prevented from doing so by the action of Parliament. With this object a suggestion has been made by an insurance manager that seems worthy of consideration. It is proposed to enact that a workman who on account of age, physical defect, or infirmity, and consequent increased liability to accident, is refused employment, shall report himself to the medical referee of the district, to be appointed by the Government for the purpose, who shall, if he is satisfied with the circumstances disclosed, issue to the workmen a certificate, and an employer engaging such certificated workman shall be required to pay to the Government a per-centage on the workman's annual wages equal to that paid by the employer in respect of healthy workmen in the same grade of employment to the insurance company indemnifying him under the Workmen's Compensation Act. In the event of accident to the certificated workman compensation under that Act would be paid by the Government direct, and liability at Common Law and under the Employers' Liability Act would be suspended. In this way, it is thought, the *bona-fide* workman might escape the odium of pauperisation, and the nation secure a pecuniary gain approximating to the cost of the keep of the workman and his dependents under the Poor-law system, less the amount, if any, by which the compensation for accidents paid by the Government exceeded the premium paid by the employer.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evening, at 8 o'clock :—

MAY 19.—"Railway Development in China." By ARTHUR JOHN BARRY, M.Inst.C.E. SIR JOHN WOLFE-BARRY, K.C.B., F.R.S., will preside.

Wednesday afternoon, at 4 o'clock :—

MAY 26.—"The Manufacture of Nitrate of Lime from Atmospheric Nitrogen." By SAM EYDE. PROFESSOR SILVANUS P. THOMPSON, D.Sc., F.R.S., will preside.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

MAY 27.—"The Function of Schools of Art in India." By CECIL L. BURNS, Principal of the Bombay School of Art. PROFESSOR SIR HUBERT VON HERKOMER, C.V.O., D.C.L., R.A., will preside.

COLONIAL SECTION.

Tuesday afternoon, at 4.30 o'clock :—

MAY 18.—"Canada as a Field for British Investment." By J. OBED SMITH, Assistant Superintendent of Emigration, Department of the Interior, Canada. The RT. HON. LORD HINDLIP will preside.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 17...British Architects, 9, Conduit-street, W., 8 p.m. Sir W. B. Richmond, "Smoke Abatement."

Victoria Institute, 12, Adelphi-terrace, W.C., 4½ p.m. The Very Rev. H. Wace, Dean of Canterbury, "Authority."

TUESDAY, MAY 18...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Colonial Section.) Mr. J. Obed Smith, "Canada as a Field for British Investment."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. J. Garstang, "The Hittites (Lecture I.), Monuments of Egypt and Asia Minor."

Statistical, 9, Adelphi-terrace, W.C., 5 p.m. Mr. R. H. Hooker, "The Meat Supply of the United Kingdom."

WEDNESDAY, MAY 19...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Arthur John Barry, "Railway Development in China."

Microscopical, 20, Hanover-square, W., at 8 p.m. 1. Messrs. E. Heron-Allen and Arthur Earland, "The Recent and Fossil Foraminifera of the Shore-sands of Selsey Bill, Sussex." (Part II.) 2. Mr. J. W. Gordon, "A New Illuminator for the Microscope."

Meteorological, 70, Victoria-street, S.W., 4½ p.m. 1. Colonel H. E. Rawson, "The Anticyclonic Belt of the Northern Hemisphere." 2. Mr. Albert Walter, "Errors of Estimation in Thermometric Observations."

THURSDAY, MAY 20...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Chemical, Burlington-house, W., 8½ p.m. 1. Mr. A. H. Salway, "The Action of Nitric Acid on the Ethers of Aromatic Hydroxyaldehydes." 2. Mr. G. Barger, "Isolation and Synthesis of P-hydroxyphenylethylamine, a Water-Soluble Active Principle of Ergot." 3. Messrs. A. W. Crossley and C. H. Hampshire, "Nitrodi-o-xylyl. (Nitrotetramethyldiphenyl). Preliminary Note." 4. Mr. F. D. Chattaway, "Ammonium Perhalides." 5. Messrs. A. McKenzie and H. B. P. Humphries, "Studies in Asymmetric Synthesis." (Part VIII.) "The Asymmetric Synthesis of 1-Mandelic Acid." 6. Messrs. W. H. Perkin and J. L. Simonsen, "Note on the Condensation of Acetone and Hippuric Acid." 7. Messrs. H. Hartley and W. H. Barrett, "Sodium Sulphite."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. J. G. Millais, "Newfoundland." (Lecture II.)

Historical, Lecture-hall, Field-court, Gray's-inn, W.C., 5 p.m. Prof. C. H. Firth, "Later Tudor Ballads."

Mining and Metallurgy, Geological Society's Rooms Burlington-house, W., 8 p.m.

FRIDAY, MAY 21...Royal Institution, Albemarle-street, W., 9 p.m. The Hon. Ivor Churchill Guest, "Afforestation."

North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, 7½ p.m.

SATURDAY, MAY 22...Royal Institution, Albemarle-street, W., 3 p.m. Dr. W. H. R. Rivers, "The Secret Societies of the Banks' Islands." (Lecture I.)

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, MAY 26, 4 p.m. (Ordinary Meeting.) HERR SAM EYDE, of Christiania, Norway, "The Manufacture of Nitrates from the Atmosphere by the Electric Arc."

THURSDAY, MAY 27, 4.30 p.m. (Indian Section.) CECIL L. BURNS, Principal of the Bombay School of Art, "The Function of Schools of Art in India."

Further particulars of the Society's meetings will be found at the end of this number.

CHANGE OF HOUR OF ORDINARY MEETING.

The attention of members is drawn to the fact that the hour of the Ordinary Meeting on Wednesday, the 26th inst., has been changed to 4 p.m.

COLONIAL SECTION.

On Tuesday afternoon, May 18th, Mr. J. OBED SMITH, Assistant Superintendent of Emigration, Department of the Interior, Canada, read a paper on "Canada as a Field for British Investment and Settlement." The RIGHT HON. LORD HINDLIP presided.

The paper and discussion will be published in a subsequent number of the *Journal*.

CONVERSAZIONE.

The Society's Conversazione this year will take place at the Natural History Museum, Cromwell-road, S.W. (by permission of the Trustees of the British Museum), on Tuesday, June 29th, from 9 p.m. to 12.

The programme of the arrangements will be announced in a future number of the *Journal.*

PROCEEDINGS OF THE SOCIETY.

TWENTIETH ORDINARY MEETING.

Wednesday, May 19, 1909; SIR JOHN WOLFE-BARRY, K.C.B., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Bader, Frederick Robert, Assoc.M.Inst.C.E., 57, Chancery-lane, W.C.
Blundell, Thomas George, 30, Ferncroft-avenue, Heath Drive, Hampstead, N.W.
Dickson, Archibald Allan Clifford, A.I.M.M., F.G.S., M.A.I.M.E., Rejoulie P.O., *vid* Nawadah, E.I.Rly., Gaya District, India.
Hay, Alexander Mackenzie, "The Statist," 51, Cannon-street, E.C., and "Marston," Warlingham, Surrey.

The following candidates were balloted for and duly elected members of the Society:—

Evans, Evan, A.M.I.E.E., Ryan-street, Stratford, Taranaki, New Zealand.
Lane, Frederick, Messrs. Lane and Macandrew, 26, Great St. Helens, E.C.
Mumm, Arnold Louis, 41 and 43, Maddox-street, Bond-street, W.
Perrott, William, B.Sc., Messrs. Johnson and Perrott, Ltd., Nelson-place, Cork, Ireland.

The paper read was—

RAILWAY DEVELOPMENT IN CHINA.

By ARTHUR JOHN BARRY, M.Inst.C.E.

Railway development in China, so far as the past is concerned, is merely a matter of history, but when it comes to considering its future prospects it is a subject which I confess I approach with much diffidence. Although I have just returnd from a visit to China, the object of which was entirely connected with railways, I do not feel that I have brought

back with me any very definite conclusions on the latter part of the subject. During the last ten years I have been closely connected with railway development in China, and, visiting the country as I do at short intervals, I may claim to have had favourable opportunities of watching the recent changes in the attitude of the Chinese towards railways. It has appeared to me that, from a frame of mind which led them to regard railways rather as a regrettable necessity, especially regrettable inasmuch as a measure of foreign assistance and control was necessary, the Chinese have gradually come to realise that the development of their railway system is a matter of prime importance to their country.

Later on I propose to return to the consideration of the condition of affairs with regard to railways which just now obtains in China; but to appreciate the various phases through which the attitude of the Chinese towards railways has passed, we must just glance at the history of the movement. This divides itself naturally into four periods.

The first period was marked by the attempt of the foreigners to induce the Chinese to permit them to introduce railways into the country, an attempt which failed before the fanatical and strenuous opposition of the governing classes.

In the second period we find an influential though comparatively small number of Chinese themselves borrowing the ideas of the foreigner, and succeeding, in face of much opposition, in bringing about the construction of the first railway in China.

During the third period, the Chinese having become more or less accustomed to railways, grasp the fact that they are necessary to the welfare of the country, and consent to the admission of capital for railway construction on mutually advantageous terms.

The fourth and present stage is characterised by a growing intolerance of foreign guidance and assistance, other than purely financial.

As regards the construction and management of railways, the Chinese are learning rapidly, but at present there are very few indeed capable of filling responsible positions which require men not only of very efficient technical education, but of experience as well. It must be many years yet before the supply of such men in China is equal to the demand.

Now this evening I will not attempt to refer in any detail to all the four stages of railway enterprise in China which I have mentioned. It would be absurd to attempt such a thing in the time available.

I propose just to touch on the first three stages very lightly, and it is the less necessary to do more than this because Mr. P. H. Kent has written a most interesting book which deals with them exhaustively, a book to which I would refer anyone who may desire to know more of the details of the past history of railway construction in China.

The fourth or present stage is the one which is of the more practical interest to us to-day, and what I propose to say on the earlier stages will be with the object of giving an idea of the principal obstacles in the way of railway developments in China which had to be surmounted before the present stage was reached.

It is more than 45 years since the first attempt was made to introduce railways into China.

In 1863 Sir Macdonald Stephenson paid a visit to China and drew up a comprehensive scheme for railway construction in that country. This scheme was presented by him to the Chinese Government, was received by them with that charming politeness for which the Chinese officials are noted; with equal politeness his document was placed in a pigeon-hole, and he himself with many expressions of esteem was bowed out of the country. If Sir Macdonald Stephenson were alive to-day, it would I imagine be some satisfaction to him to know that his scheme, or something very like it, is now being acted upon.

The next move emanated from Shanghai, the greatest and wealthiest foreign commercial centre in China. A proposal was put forward to construct a short railway from Shanghai to Woosung, about 12 miles down the Whang Poo river, beyond which point ocean-going steamers, owing to the existence of a bar, cannot pass without previously discharging much of their cargo. Permission to construct this short line was refused, but the subsequent application of Messrs. Jardine, Matheson and Co., the well-known Chinese house, to construct an ordinary road was sanctioned. When the road had been constructed, that is in the year 1875, Messrs. Jardine commenced to lay down upon it a 2 ft. 6 in. gauge railway. Under the late Mr. G. J. Morrison, as resident engineer, the work of construction proceeded smoothly, and when the first section of the line was opened, it was enthusiastically patronised by the Chinese, and promised to be entirely successful.

Notwithstanding all this, however, the project was doomed to ultimate failure.

One day, prompted, as many thought, by the officials, a coolie threw himself under the train and was killed. As a result of the commotion thus aroused and the subsequent inquiry the line was condemned and closed, purchased by the Chinese Government at cost price, and rails, sleepers, rolling stock, &c., were bundled out of the country. The credit, therefore, of building the first railway in China is due to Messrs. Jardine, Matheson and Co., and of being the first engineer to the late Mr. G. J. Morrison, who lived long enough to see the next project in which he interested himself, viz., the Shanghai-Nanking Railway, and in which he was associated with Sir John Wolfe-Barry and myself as consulting engineers, nearly completed. With the destruction of the first Woosung line ends what we may call the first stage of railway development in China.

Although Messrs. Jardine, Matheson and Co.'s efforts to introduce railways into China had been a failure they were destined to bear fruit ere long.

Amongst those who had seen the Woosung line in operation was a certain Chinese gentleman by name Tong Kin Sing, a near relative of H.E. Tang Shao Yi, who has just recently visited this country, and who in many ways resembles him.

The name of Tong Kin Sing deserves to be much better known than it is. He was a man of enlightened views, broad and liberal-minded, tenacious of purpose and public-spirited. He may perhaps be called the father of industrial enterprise on sound lines in China. Amongst other enterprises that Tong Kin Sing inaugurated was the first coal-mine to be worked on a large scale and on modern lines in China, and it was at his coal-mines at Tongshan in the north of China that the first step was taken which led to the construction of the first permanent railway in China. His first little railway was designed to bring coal from his pits to the head of a canal about seven miles distant. From this small beginning has grown up the most important railway system in China, about 600 miles in length, connecting Pekin with Mukden, the capital of Manchuria and the old home of the present reigning dynasty. It there joins up with the through route to Europe *viâ* Siberia.

Tong Kin Sing would never have been able by himself to bring about this great achievement; it might, in fact, never have been brought about had not Mr. Kinder been appointed engineer in charge of the construction of the tramway. Mr. Kinder is the most modest of men. I will not attempt to say all that justly might be said in praise of him. Difficulties that would to most men have been insuperable were to him merely obstacles that had either to be got over or to be got round. Facts are more eloquent than words, and the facts remain that he began by constructing a seven mile colliery tramway, and during 30 years of faithful service to the Chinese, under his fostering care, that seven mile tramway has developed into the great railway system I have just described.

Mr. Kinder has at last just resigned his position as chief engineer of the Imperial Railways of North China and returned to this country. If to Tong Kin Sing belongs the credit of initiating the first great railway in China, to Mr. Kinder, belongs the credit of creating it, thanks to the support he received from Li Hung Chang, the great viceroy and and the most powerful man of his time in China, to whose favourable notice he was introduced by M. Detring, the then Commissioner of Customs at Tientsin.

In the limits of this paper it is impossible even to mention all the vicissitudes through which the venture had to be conducted, or all the obstacles that had to be surmounted or circumvented. By dint of dogged pertinacity and skilful diplomacy the line was extended to Tongku, then to Tientsin, then to Pekin, then to the Great Wall, and finally to Mukden. Before this was done the fierce opposition of reactionary officials had to be faced as well as the superstitious antagonism of the people, "Fengshui" and the grave difficulties being chiefly responsible for the latter.

As one example of the former no sooner had Tong Kin Sing, backed by Li Hung Chang, obtained permission from Pekin to build his first seven miles of line than the permission was incontinently withdrawn. This was of course rather a severe blow, but he compromised matters by getting permission to make a tramway to be operated by mules. Whilst the formation was being constructed, Mr. Kinder started to work to build on the quiet a locomotive out of any odds and ends he could pick up. He got a boiler from an old portable engine, cylinders from another, wheels from a scrap heap, and the rest he built with native workmen in a shed behind locked doors. In the end he turned out a very serviceable locomotive. When at a suit-

able moment this was put on the line it was accepted by the Chinese as a *fait accompli*; and having become accustomed to it the Chinese Government raised no objection when it was replaced by locomotives from England. This engine, the Rocket of China, now stands in the fine new locomotive shops at Tongshan as a memento of the past.

If official opposition to railways is now merely a matter of history, popular superstition still exists, though in a modified form. Fengshui is still a power to be reckoned with, and interference with graves is still a difficulty. Fengshui is a geomantic mystery far beyond the scope of a mere Western intellect to grasp. The Fengshui of a place, a town, a village, or a building is, as nearly as I can express it, the luck of the place, but what that luck depends upon only the wise man skilled in the mystery can say, and some of the conclusions arrived at after solemn investigation by the sages of Fengshui would put to shame the pronouncements of the wizards of the middle ages. Spirits have to be taken into account and their accustomed movements only the wise man knows. He only therefore can tell you whether the line you have laid out, or the works you propose to construct, will interfere with the habits of the unseen world or not, and whether any, and if so what, modification must be introduced. You will appreciate, therefore, that Fengshui was, and to a decreasing extent still is, a potent and mysterious factor that has to be taken into account in railway construction in the Celestial Kingdom.

The grave question however is a simpler one. The Chinese are ancestor worshippers, and sad is the fate hereafter of one who permits the bones of his ancestors to be lost or scattered. To allow them to be disturbed at all used to be counted as a sin, but to-day the Chinaman of the lower middle and lower classes has arrived at the conviction that an ancestor will probably forgive him if the ancestral bones are reverently removed from their ancient resting-place and decently interred elsewhere. In all this there is very little difference between the Chinese and the European, but since the Chinese bury their dead on any piece of unoccupied ground, it is generally impossible to lay out a railway without interfering with graves. Nowadays this is no longer an insurmountable difficulty, for the business instincts of the Chinese have triumphed over superstition, if it may be so called, and his feelings may be salved by a suitable consideration. Any qualms of conscience that may assail him are dispelled by the knowledge that if his filial piety is expressed by sufficiently vehement conscientious objections, the amount of compensation he will receive will be proportionately higher. He must, however, be wise enough not to overdo it, for there are several sad cases, when in deference to the eloquent objections of living representatives of past generations, the centre line of a railway has been deviated, and no entreaty could bring it back again to where it was before.

The grave question in China has now become almost entirely a financial one, but it is still serious, for whenever compensation for disturbance is being paid it is remarkable how large a number of ancient and forgotten graves find owners. To make sure that a claimant really has a grave to claim upon, sometimes it is the rule to insist on each claimant producing the ancestral relics for inspection, and I know of one unfortunate man who was moved to genuine tears and despair, because after having done a brisk business in hiring out his parents' bones at 50 cents a time to eager applicants for compensation, one of them was careless enough to lose them, with the dire consequence to that enterprising representative of a family, that in the future world he would have no friend to welcome him.

But to return to what is now known as the Imperial Railway of North China. I have no time to touch upon the events which led to British capitalists becoming associated with the enterprise, nor can I describe the political difficulties to which the extensions of the railway gave rise, and the hostility of the Russians who saw in British energy asserting itself in Manchuria, a menace to their scheme of empire. I have no time even to explain the part played, during the Boxer rising, by the railway, or how England and Russia nearly came to blows about it when the rising was suppressed. How successful the railway is to-day, is evidenced by the fact that last year the total gross receipts amounted to about 11,000,000 taels, while the working expenses were only about 3,000,000 taels, showing a net profit of something like 8,000,000 taels, or say £1,000,000 sterling.

In 1894 war broke out between Japan and China; the close of the war marked the close of the second period of railway development in China and the commencement of the third. The disastrous result of the Chino-Japanese war was to China a profound surprise and humiliation. The foe whom she held in con-

tempt, had defeated her with ease, and if China's immense though untrained numbers, even if they had been available, might have altered the result of the war, want of means of rapid transport had prevented her from using them. Many of the more enlightened officials realised this, and grasped the fact that the remedy of the defect lay in the construction of railways.

There was no difficulty in obtaining the capital required for this purpose from abroad, for nearly every nation in Europe, as well as America, was willing and anxious to lend China the money she required on mutually advantageous terms, but at first it would appear that the Chinese Government cherished a hope that the capital required would be provided by her own people. That the necessary capital was not forthcoming in China is hardly surprising. The idea of private companies for the purpose of carrying out public enterprises did not appeal to the Chinese investor, and he had some reason in being shy, for the Chinese Government had shown an awkward way of taking over private companies after they became successful, and in a somewhat arbitrary manner taking them over at their own price.

Another feature of the situation at this time was that Russia, France, and Germany had each of them in view a definite programme of railway expansion in China, the objects of which were not merely the profitable investment of capital and the expansion of markets for their productions. Territorial extension under certain eventualities was perhaps an object of greater importance still. Russia was anxious, and reasonably anxious, to cut off an awkward corner that spoiled the alignment of her great Siberian Railway to Vladivostock, and take a short cut through Manchuria instead; an ice-free port in Eastern waters was also an object that Russia could not afford to lose sight of. Kiao Chau would, perhaps, be the best, but if not, Port Arthur and Talienwan had much in their favour.

Then, again, in the possible event of a partition of China, Russia could not regard with equanimity the prospect of Manchuria, Mongolia, Chili, and perhaps other provinces on the border of her Empire falling into the hands of any other power. For the moment, however, Manchuria was the principal object in view, and a policy of peaceful penetration was indicated.

France, on the other hand, had her interests in the south. Kwangtung, Kwangsi, and Yunnan all border on French Indo-China, and if Fate should decree a break-up of China, there was no doubt as to which pieces it behoved France to be ready to pick up. In the meantime it would be well to establish definite interests in these provinces, and at the same time railway communication between China and Cochin China would benefit the trade of the latter colony.

The idea of direct communication by railway with Russia, her ally now firmly established in the north of China, was also perhaps an object to be borne in mind.

The position of Germany was different: so far she had not got a definite footing in China, and with her rapidly expanding trade interests she very naturally determined that she was not going to be left behind when the time came, if it ever did come, for the division of the Chinese Empire. The province of Shangtung, with its valuable harbour at Kiao chau, seemed indicated as the natural object of German enterprise; and when the first opportunity presented itself Germany was ready and took it. In due time these various political aspirations took concrete form, and as a result the following railways came into being:—

First, the Russian railway, called the Eastern Chinese Railway, from the station on the Siberian railway called Manchoarie, through Tsitsihar and Harbin to Vladivostock, with a branch from Harbin to Yingkow, Port Arthur, and Talienwan.

Secondly, in the south, the French projected railway from Lao kai to Yunnan, which it is expected will be completed next year.

Thirdly, the German railway in Shantung between Kiao chau and Chinan Fu.

These railways came into existence in the following manner. It will be remembered that under the terms of the treaty negotiated by Li Hung Chang on behalf of China, which followed the Japanese war, China was compelled to cede, in addition to Formosa, Korea, Port Arthur, and Shantung. Under pressure from Russia, France, and Germany combined, Japan was forced to return these territories to China. Soon after this Li Hung Chang paid a visit to Europe, going first to Russia at the invitation of the Czar, to be present at his coronation. From that date Li Hung Chang became a firm friend of Russia. The first result of this was the agreement made between China and the Russo-Chinese Bank, a semi-official institution founded to promote Russian interests in the East. Under this the bank

acquired the right to form a company, in which only Russians and Chinese could hold shares, to construct a railway across Manchuria to form part of the through line to Vladivostock. This company was called the Eastern Chinese Railway Company and is of course a purely Russian company. It had unhampered control of the construction and working of the line, although the Chinese have the right to repurchase the railway in 36 years, and it is to revert to them absolutely in 80 years, by which time of course many things may have happened.

In 1898, under circumstances to which I will refer later, Germany occupied Kiao Chau, and obtained a 99 years lease of the port, whereupon Russia demanded and obtained a 25 years lease of Port Arthur and the Liao Tung Peninsula and a right to construct a branch from the Trans-Siberian Railway at Harbin to Port Arthur and Talien-wan. The Siberian Railway was opened throughout for traffic in 1901, after having taken only ten years to build, and anyone who has passed over that route at any time during the long Siberian winter, travelling day after day for eight days through a waste of snow with a temperature well below zero, must realise the difficulties that the Russians had to face in building that railway. To have completed successfully the building of 4,750 miles of railway under such conditions is a stupendous task, and to have carried it out successfully in so short a space of time as ten years is a record of which the Russians may justly be proud.

Since the Russo-Japanese war, the Eastern Chinese railway south of Kwangchengtsze has been converted to the 4 ft. 8½ in. from the Russian 5 ft. gauge. The Japanese have also a hastily constructed line from near Newchuang to the Yalu river. This railway they are now improving, and before very long probably passengers will be able to go by train from London to Fusan.

We will now consider the position of France in the south of China. In 1895, France obtained from China an acquiescence to her project of extending her railway system in Annam into Chinese territory. In 1898, Russia, Great Britain, and Germany, having been granted important railway rights in the north, by way of balancing up, China granted to France a lease of Kwangchauwan as a coaling station, and the right to construct a railway to Yunnan Fu.

The capital required for this undertaking was estimated at a little over £4,000,000. Of this sum £3,000,000 was raised on a joint guarantee of the Colonial and Republican Governments, the balance being subscribed half by a company and half by the Indo-Chinese Government. The total length of the line is 280 miles; eighty years after the date of completion the railway is to revert to China. Construction was commenced in 1903; some very heavy work in the deadly Namting Valley has been the cause of some delay and the loss of a great number of lives amongst the workmen. The railway will, however, be completed some time next year.

In 1898, the murder of a French missionary in the south led to a demand by France of concessions for further railways in the Kwangsi Province, but apparently nothing very definite was arranged.

We now come to the subject of the German railways in Shangtung.

The opportunity of putting into practice Germany's scheme for the expansion of her interests in China was afforded by the murder of two German missionaries in Shangtung. This occurred in 1897. Without delay the German Fleet in Chinese waters seized Kiao Chau Bay, and the German Government refused to evacuate it until her demands for compensation to the families of the murdered missionaries, the degradation of the Governor of Shangtung, and certain rights in Shangtung, were acceded to. After demur the Chinese Government acceded to these, but as Germany was not prepared to put any faith in Chinese promises, she insisted on occupying Kiao Chau until they were carried out. She further demanded a guarantee for the protection of the lives of German subjects in China in future.

The form this guarantee took was a lease for 99 years of Kiao Chau Bay and a portion of the province of Shangtung. At the same time Germany obtained the right to construct certain railways in that province. These railways were as follows:—A line from Tsing tau through Kiao Chau to Chinan Fu, a line from Kiao Chau to a point on the frontier of Kiangsu near the Grand Canal, and a line joining up the termination of these two railways.

These railways were to be constructed by a German company in which the Chinese were to be allowed to become shareholders if they chose. In 1899 the company was formed and commenced to construct the railway from Tsing tau to Chinan Fu. This line was opened for traffic in 1904, and is now a paying concern; it is about 240 miles long.

The German Government have spent a great deal of money at Tsing tau on the coast of the Kiao Chau Bay, and have created a very fine port there. When the railway between Chinan Fu and Tientsin is completed—it is now under construction, and will be referred to later—Tsing tau will become a serious competitor with Tientsin for North China trade, and still more so when the projected railways to put it in communication with Cheng ting and Kai feng are carried out.

The southern railway from Kiao Chau to the Kiangsu boundary has not been commenced as yet, but the third line running south from Chinan Fu is under construction as part of the Tientsin-Pukow Railway, for which an Anglo-German syndicate has found the money, and to which reference will be made later.

I have purposely grouped together the three railway systems just described, viz., the Russian, German and French, because the conditions which govern their inception and construction are entirely different from those other railways which came into existence, or, at any rate, were commenced during the third period of Chinese railway development.

This group of railways owes its origin to political rather than commercial aspirations. They are to all intents and purposes the property of the three countries named, and to them must now be added Japan, who is the proprietor of the South Manchurian Railway. China has little or no control over them; they are concessions in the true sense of the word.

In the case of the remaining railways, the sovereign rights of China are not impaired and although the instruments under which the capital has been raised are frequently called concessions, the word is a misnomer as applied to them. The loan agreements between the Chinese Government and the various syndicates concerned are all practically similar in principle. The Chinese Government borrows money at 5 per cent. interest; the syndicates are granted facilities and privileges which enable them to make sure that the money they lend shall be spent honestly and economically upon the object for which the loan is advanced. The loans are secured in the first instance by a mortgage on the railway itself, and in addition to the guaranteed 5 per cent. interest a small share in surplus profits is granted. The profits of the syndicate are represented by any difference there may be between the issue price and the price which the Chinese Government agree to take for each £100 bond, after deducting all preliminary expenses, cost of issue, underwriting, &c. In addition, the syndicates usually act as agents for the supply of material and are permitted to charge a commission on the cost.

In the supply of material, where possible, Chinese manufactures are to be preferred if of equal quality and price to those obtainable elsewhere, and next to those the manufactures of the country to which the syndicate belongs are to be given a preference.

Now the list of railways which belong to the third period, and for which the capital was raised on the general principles above named, is rather a long one, and I do not purpose to enter into any detail in connection with any except three, the circumstances connected with the initiation of which had a distinct influence on the progress of the general railway development.

The list of railways which belong to the third period is as follows:—(1) The Pekin-Hankow, (2) Hankow-Canton, (3) Pekin Syndicate Railway (bought by Chinese), (4) Cheng-ting-Fu-Taiyan-Fu Railway, (5) Kaifeng-Fu-Hsian-Fu Railway, (6) Pinghsiang-Chu chow, (7) Pekin-Kalgan (Chinese), (8) Swatow-Chauchau, (9) Macao-Canton, (10) Shanghai-Nanking.

Of these ten railways it is only necessary to refer at any length to three, viz., the Pekin-Hankow, the Hankow-Canton, and the Shanghai-Nanking.

I will just briefly mention the other seven lines.

(1) The Pekin Syndicate Railway.—90 miles long, was built by the Pekin Syndicate to convey coal from the mines when opened to a point on the Wei River, whence it was intended to convey coal to the market by boat. Since it has been completed the Chinese Government have bought it up: it does not pay.

(2) Chanting-Fu-Taiyuan-Fu Railway. — 160 miles long. A French syndicate took the line over from the Russo-Chinese Bank; metre gauge line; now completed. It should pay well.

(3) Kaifeng - Fu - Hsian - Fu Railway. -- Finished. The extension to Haian-Fu has yet to be built. The line is about 140 miles long, and is being constructed by a Belgian syndicate.

(4) Pinghsiang-Chuchow.—Built by European engineers with Chinese capital. It is 60 miles long and connects the Pinghsiang coal mines with the Hsiang-Kiang river.

(5) Swatow-Chao Chau-Fu.—A short railway, 30 miles long, built by Japanese engi-

neers for a Chinese, who made a very large fortune, as so many Chinese do, in the Straits Settlements.

(6) Macao-Canton Railway. — Being constructed by a company, half of whom are Portuguese and half Chinese; it is 130 miles long.

(7) Pekin-Kalgan Railway, 125 miles long; it is nearly completed, and is being built entirely under Chinese supervision out of the surplus profits of the Pekin-Tientsin Mukden Railway. There is some heavy work, including tunnels, at the Nankow Pass, where a gradient of 1 in 30, for 12 miles, has been introduced. Mr. Jeme Tien Yow is the chief engineer, and the way he has carried out this importaut work reflects great credit on him. He is the most capable Chinese engineer in China; he was educated in America, and gained his experience under Mr. Kinder.

We now come to the Pekin-Hankow Railway. In what has been called "the battle of the concessions," which took place soon after the close of the Chino-Japanese war, a very prominent position was taken up by Belgium. Russia, France, and Germany had each a definite policy in view, whilst Great Britain, who at the time considered herself as chiefly interested in the trade of the Yangtsze Valley, made it her business, so far as she could, to preserve the freedom of that trade unhampered by foreign interference. Belgium, on the other hand, had no special policy, except to find new markets for the products of her great iron industries and at the same time to do profitable financial business. On the other hand, she had no powerful army or navy with which unaided to ensure the respect of China. It was more or less necessary, therefore, for Belgium to attach herself to more powerful nations. France and Russia were indicated. Russia had been protesting against English activity in the north of China, and had come to an arrangement under which, in return for an undertaking on the part of Great Britain not to seek railway concessions north of the Great Wall, and not to place obstacles in the way of any enterprise there backed by Russia, the latter would give a similar undertaking with regard to the Yangtsze Valley. Russia could not, therefore, very well appear openly in the field in the Yangtsze Valley.

France, again, had her hands pretty full in the south of China and her relationship with Russia being so intimate, England might regard any special activity on her part in the Yangtsze Valley with some suspicion. Obviously, therefore, just as France and Russia could be very useful to Belgium, Belgium could be very useful to France and Russia.

It was at a time when this condition of affairs obtained that China proposed the construction of the Pekin-Hankow Railway. This was the first railway for the construction of which the Chinese Government invited the co-operation of foreign capitalists. After the Japanese war, the Chinese Government regarded the Pekin-Hankow Railway as a work of urgent necessity. Several attempts were made to raise the capital required by means of a Chinese company, but this of course failed. The Chinese then opened negotiations with an American group of financiers, who sent a party of American engineers along the proposed route to make a reconnaissance survey, but whilst negotiations with this group were in progress in Pekin, *i.e.*, in 1897, a Belgian syndicate appeared on the scene and underbid them, accepting practically all the terms offered by the Chinese without discussion. Having secured the concession, the Belgian syndicate found of course that it was unworkable, and with the help of diplomatic pressure, in which they were assisted by France and Russia, improved conditions were obtained. The appearance of France and Russia on the scene was considered by Great Britain as ominous, Russia having already established herself in the north and France in the south. If, through the Belgians, France or Russia, or both jointly, got control of the connecting link through Pekin to Hankow, and Hankow to Canton, there would be reason to fear that British interests in the Yangtsze Valley would be threatened. The Tsung-li-Yamen (in other words the Chinese Foreign Office, now called the Wai Wu Pu) assured the British Minister in Pekin that the concessionaires were a *bona fide* Belgian group, and had no political intentions. Information obtained by Dr. Morrison, the famous *Times* correspondent in Pekin, indicated that the statements by the Tsung-li-Yamen were opposed to facts, and the China Association in London urged the Government of the day to take steps to protect the British interests in the Yangtsze Valley that were then threatened. Sir Claude Macdonald in Pekin obtained a solemn assurance from the Tsung-li-Yamen that the Russo-Chinese Bank were in no way interested in the project, and immediately afterwards the agreement with the Belgians was signed. In the meantime, what purported to be a copy of the contract with the Belgians was published by

an English paper in China. So far the British Minister had not succeeded in being allowed to see a draft of the concession, but if the copy as published was correct, the statements made to him by the Tsung-li-Yamen were clearly untrue.

On inquiry, Sir Claude was informed by the Tsung-li-Yamen that the copy of the contract as published in the newspaper was incorrect, and an undertaking was given that no clauses admitting the Russo-Chinese Bank to participate in the project should receive Imperial sanction. Without further ceremony the contract was formally ratified.

As soon as this contract was published it became apparent that, notwithstanding the definite statements made by the Tsung-li-Yamen, the Russo-Chinese Bank were specially charged with all financial arrangements during the currency of the loan. Under the terms of the agreement the Belgian syndicate undertook to finance an issue of 5 per cent. bonds to the value of the equivalent in francs of £4,500,000 at 90 per cent. of their face value; the bonds were secured on the net receipts of the railway, and the interest was further guaranteed by the Chinese Government.

The syndicate had the right to direct the construction of the line, and for the supply of material Belgian manufacturers were to have preference. The syndicate also were to control the working of the line when completed, and were to receive 20 per cent. of the surplus receipts after the payment of expenses and interest on the bonds. The Chinese Government reserved the right to repay the loan at any time after 1907 and take over the railway. The loan was in any case to be repaid during a period of twenty years, commencing in 1909. It should be added that when the loan was issued four-fifths were subscribed for in France.

The length of the railway is 760 miles and serves a densely populated country. The cost of the line is supposed to have been about £5,000,000. After the Boxer rising the syndicate successfully claimed a sum of £960,000 as compensation for damage done to the works. The permanent way consists of 85 lb. rails laid on Japanese sleepers. These sleepers are cheap so far as first cost is concerned, but last a very short time. In several places the line has been washed away more than once during floods, but more bridges have been provided from time to time. The principal work on the railway is the great Yellow River bridge, nearly two miles long, consisting of 102 spans 65 and 98 feet in length. The piers consist of screw piles screwed about 36 feet into the extremely fine treacherous and bottomless silt of which the river bed consists. Each pier is protected from scour by pitching stone. Ordinary pitching is useless here as it rapidly goes out of sight or is carried down stream. Mattresses of rushes and brushwood are therefore laid round the piers and pitching stone is placed upon this, but to maintain the pitching is a constant war with nature. To take the trains across the bridge the heavy main line engines are cut off and light ones attached.

The railway earns large profits, although it does not pay so well as the Imperial railways of North China. I should add that last year the Hongkong Bank issued a Chinese Government loan in London for £5,000,000, secured on the provincial taxes of the provinces of Chikiang, Kiangsu, Hupeh and Chihli, and out of the proceeds of this loan the Chinese Government has just exercised its right of repurchase and has taken over the line.

We now come to the Hankow-Canton Railway, which may be regarded as a continuation of the Pekin-Hankow, and when constructed will complete the great north and south trunk line from Pekin to Canton and Hongkong.

When the Americans were compelled to retire from the negotiations for the construction of the Pekin-Hankow Railway in favour of the Belgians, they appear to have received a promise that the concession for the southern section from Hankow to Canton should be given them instead, and in 1898 a contract was signed between the Chinese Government and the American Development Company, of which Mr. Calvin Brice was president. Under this contract the American company agreed to provide the estimated sum required for construction, viz., about £4,000,000, for which amount the Chinese Government were to issue 5 per cent. gold bonds to a value which at 90 per cent. of their face value would produce that sum.

The Development Company were to construct the line, and were to be allowed 5 per cent. on the cost of construction except land and earthworks, as remuneration for general services. They were also entitled to 20 per cent. of the net profits of working after payment of interest and working expenses. The length of the railway is about 742 miles.

When, however, a careful survey of the route had been made it was found that the

cost of the line had been much under-estimated, and that £8,000,000 instead of £4,000,000 would be required. It became necessary therefore to negotiate a modification of the contract.

In these negotiations the Americans found themselves opposed by Belgium and France, but in the end they carried the day, and the terms of the contract were successfully adjusted. All now being ready to proceed with raising the capital, the Development Company invited the assistance of British capitalists. Most unfortunately, however, the South African war had broken out in the meantime, and no great amount of capital could be raised in London.

Another misfortune was the death of Senator Brice. No one appears to have been forthcoming to fill his place successfully, and as a consequence it was found hardly possible to raise the capital in America. This gave the Belgians an opportunity; they began to buy up the shares of the American Development Company, and soon gained the control of it. They appointed their own representative as President, and the American engineers in China were replaced by Belgians. This alarmed the Chinese, who had made it a condition of the loan agreement that the Americans should not transfer their rights to other nationalities. The Chinese authorities refused to accept Belgian control of the railway, and a keen dispute arose as to whether China had any right to object, seeing that the Development Company still remained an American company although the *personnel* was mainly Belgian. Russia's hands at that time being tied by the Russo-Japanese war, and the Japanese victories having taken their effect at Pekin, the Chinese Government remained firm. At this juncture Mr. Pierpont Morgan came forward, and shortly afterwards the Development Company was able to show that it was American once more in reality as well as in name.

Unfortunately this did not help on the construction of the railway; no more capital was forthcoming, and in 1905 an arrangement was made between China and the American company whereby the contract was cancelled, the Development Company receiving £1,350,000 compensation for work done and prospective profits. It was believed by the Chinese Government that this sum would soon be subscribed by the native gentry of the provinces affected, but again they were disappointed. The Government of the colony of Hongkong now came to the rescue, and lent the £1,100,000 (the balance required by China) at 4½ per cent. secured on the opium revenues of Honan, Hupeh, and Kwangtung. The loan is redeemable in ten years. The Chinese agreed that, if foreign capital should be required for the construction of the line, or for the projected Hankow-Chengtu Railway, British financiers should have the preference. The remaining history of the Hankow-Canton Railway belongs to the present day period of railway development, and will be referred to again.

The last railway belonging to the third period of Chinese railway development is the Shanghai-Nankin Railway, which was inaugurated under British auspices, as indeed are practically all those which we shall come to now in considering the fourth or present day period.

In 1898, Messrs. Jardine, Matheson and Co., in alliance with the Hongkong and Shanghai Bank, had applied to the Chinese Government for the right to construct, under conditions to be agreed, the Shanghai-Nanking Railway, and a preliminary agreement authorising the construction of the railway in question was signed early in that year. This agreement indicated the general conditions on which the railway was to be constructed, conditions practically the same as those granted for the Pekin-Hankow and Hankow-Canton Railways, and this agreement was to be followed by a more definite final contract.

The same group also applied for similar agreements for the construction of the following lines:—The Soochow-Hangchow-Ningpo Railway, Tientsin-Chinkiang Railway, Pukow-Sinyang Railway, and the Canton-Kowloon Railway.

In the same year, after what was looked upon as a breach of faith on the part of the Chinese Government, in connection with the signature of the contract with the Belgians, for the construction of the Pekin-Hankow Railway, to which I have already referred, the British Government insisted on the granting by China of the concessions applied for by Messrs. Jardine, Matheson and Co. and the Hongkong Bank.

To this demand the Chinese Government acceded, it being arranged that whatever form the final contract for the Shanghai-Nankin Railway might take the contracts for the remaining lines should be similar.

About this time Messrs. Jardine, Matheson and Co. and the Hongkong Bank formed a

combination with another group of leading British financiers, and the British and Chinese Corporation was founded.

The outbreak of the Boer war had made it for a time impossible to proceed with the construction of the Shanghai-Nankin Railway, but negotiations for the final agreement were set on foot. At the same time the British and Chinese Corporation had surveys made of all the other railways just mentioned. It was not until 1903 that these negotiations came to a successful issue and the final agreement for the construction of the Shanghai-Nankin Railway was signed and ratified by an Imperial decree.

The principal conditions of the agreement were as follows:—

The British and Chinese Corporation undertook to issue a loan for £3,250,000 at 90 secured by Imperial bonds, bearing interest at 5 per cent.

The bonds were secured by a mortgage on the railway and were in addition unconditionally guaranteed by the Chinese Government; the loan was to run for 50 years, but could be redeemed at 102½ after 12½ years, and at par after 25 years. The existing Woosung Railway was to be purchased for £125,000; land was to be provided free of charge, but the Corporation undertook to advance a sum of £250,000 to the Chinese Government to enable them to purchase the necessary land.

A board of five commissioners, of whom two were to be nominated by the Corporation, and two by the Chinese Government, were to be appointed, to take charge of the general direction and construction of the railway. The chief engineer was to be nominated by the Corporation and approved by the Chinese Government. He was to be *ex-officio* a member of the Board of Control. All other appointments were to be in the hands of this Board. For the construction of the railway, British manufactures at equal quality and prices were to have the preference over other foreign material.

In July, 1904, the first issue of £2,250,000 was made. The bonds were offered to the public at 97½. The issue was a moderate success, although the investing public did not by any means make a rush for it as they do now for Chinese loans on infinitely less favourable conditions.

A great deal of difficulty was experienced in getting possession of the necessary land at first. This was unfortunate, since it meant waste of money in the way of salaries to the staff, &c., and interest on the loan paid out of capital. When, however, a fair start could be made, the work of construction proceeded rapidly. The first section of the railway was opened to traffic to Naziang on November 20, 1905, and in the following July to Soochow and Wusieh; to Chan-chow on May 15th, 1907; to Chinkiang on October 15th, 1907; and on March 28th, 1908, the first train ran from Shanghai to Nanking.

Under the terms of the contract with the Chinese, it was stipulated that a first-class railway in accordance with the best modern system should be constructed. This has been done, and the Shanghai-Nanking Railway will compare favourably with any line in England or elsewhere, whilst there is no doubt it is the best found railway in China. The railway serves a wealthy district, the resident population of which are well off, and, as events have proved, quite appreciate comfort in travelling.

Between Shanghai and Soochow, for example, the railway runs parallel with the Soochow Creek, along which waterway numerous trains of passenger boats towed by steam used to pass daily each way. It used to be said that the railway would not be able to compete with these boats, but now, owing to the greater comfort and speed with which passengers by train are carried, these boats have been taken off, as the railway attracts all the passengers. The passenger traffic of the railway is extraordinarily heavy, and the liberal supply of passenger stock with which it has been provided is already being found insufficient to meet the requirements of this increasing traffic. As regards goods traffic, the railway has not as yet been so successful, the reason being that all goods carried by the railway have to pay far higher charges in the way of likin or inland revenue than goods carried in boats. The result of this is that, although the railway can carry goods more cheaply, safely, and quickly, the extra likin charges more than counterbalance these advantages. It is possible that in the end this difficulty will be adjusted, and if the likin charges on goods carried by railway are made the same as by water, I have no doubt that the goods traffic on the Shanghai-Nanking Railway will become as satisfactory as the passenger traffic is already. Attempts have been, and are being made, to get this anomaly removed, by Mr. Wong Ching Liang, the very able and enlightened Chinese managing director, and Mr. Pope, C.I.E., the general manager, but several

difficulties have to be surmounted, and some of these are complicated by the fact that likin collected on the railway belongs to the Imperial Government, whilst that collected on boat cargo is credited to provincial revenue.

If the Shanghai-Nanking Railway, however, is to be as successful as it ought to be, the Soochow-Hangchow-Ningpo Railway should, when completed, be worked with it as one system, as originally intended. The terminal station, the locomotive shops, &c., were all designed and constructed with this object in view. The charges for general direction and departmental offices ought to be charged against both railways, which together would comprise a system of 500 miles instead of only 200.

Unfortunately, the Chinese Government, under circumstances to be mentioned directly, have not adhered to the terms of their agreement with the British and Chinese Corporation for the construction of the Soochow-Hangchow-Ningpo Railway, and have handed over the construction and presumably the control of that railway when constructed, to a Chinese local company to which I shall refer later.

The terms granted in the case of the Shanghai-Nanking Railway loan mark the extreme concession that the Chinese Government will ever make to foreign bondholders. Such terms will never be repeated. Before the Shanghai-Nanking Railway loan was issued it was difficult to raise money in London for Chinese enterprises; at the present time, however, practically any Chinese 5 per cent. loan attracts a rush of investors to whom the Chinese Government's guarantee is everything, and the other conditions of the loan are of secondary importance. That the Chinese Government will always pay so long as they have the wherewithal to do so, is, I hold, fairly certain—if there is any question, it is, whether they will always be able to pay.

Conscious of the improvement in their credit, it was natural that the Chinese Government regretted having promised the same conditions for the other railways which are now under construction, as they had agreed to in the first instance for the Shanghai-Nanking Railway, and in the light of more recent experience in things Chinese it was not surprising perhaps that they refused to abide by the preliminary agreements and to sign the final agreements for these unless the terms were modified. It was also natural that in consequence of this attitude the negotiations for the final agreements for the loans for these later railways were protracted and troublesome.

The fourth period of railway construction in China I regard as commencing with the negotiations for the Canton-Kowloon Railway loan which was the first to be undertaken of the later railways to which I have just referred.

The second of these was the Tientsin-Pukow line, which is now under construction.

The third to be undertaken was the Shanghai Hanchow-Ningpo line, which now starts from Shanghai instead of Soochow as was originally intended.

The agreement for the Pookow-Sinyang line, the last of the railways for which preliminary agreements have been signed, has not yet been negotiated, and negotiations in this case are more difficult than ever.

In the case of the Canton-Kowloon Railway the Chinese insisted on the following modifications of the Shanghai-Nanking Railway terms. Instead of the railway being managed by a Board of Control on which the bondholders are represented, a Chinese managing-director was substituted, in whose hands the management of the railway is vested both before and after construction. Instead of the chief engineer being appointed by the representatives of the bondholders, he was to be nominated by them subject to the approval of the Chinese. Instead of the direction of the work of construction and the subsequent management of the railway being in the hands of the chief engineer, his functions on the Canton-Kowloon Railway are limited to those of adviser to the managing director, but it was agreed that no payments may be made from the loan funds except on requisitions countersigned by the chief engineer.

On the Shanghai-Nanking Railway the accountant was appointed by the Corporation, and all the accounts have to pass through his hands, he being responsible to the Board of Control. In the case of the Canton-Kowloon Railway the accountant was appointed on the recommendation of the representatives of the bondholders subject to the approval of the Chinese managing director, whose servant he is. His duties are to organise and supervise the accounts, and report thereon to the Viceroy through the managing director.

In the case of the Shanghai-Nanking Railway, the original bondholders had an interest in any surplus profits of the railway over 5 per cent.; in the case of the Canton-Kowloon Railway they have none. The issue price of the first Shanghai-Nanking Railway loan was $97\frac{1}{2}$ per cent.; that of the Canton-Kowloon Railway was 100 per cent. The Chinese re-

ceived 90 per cent. of the nominal value of the Shanghai-Nanking Railway loan, they received 94 per cent. in the case of the Canton-Kowloon Railway loan. The Shanghai-Nanking Railway loan was to run for fifty years—the Canton-Kowloon Railway for thirty years only. In both cases the railways are mortgaged as collateral security.

Notwithstanding these important modifications in the original conditions of the loan that have been introduced, the agreement has, in practice, been found satisfactory. The relationship between Mr. Wei Han, the Chinese managing director, and his British assistants, is excellent, and complete harmony based on mutual confidence and respect prevails.

The Canton-Kowloon Railway is a very important line, 100 miles in length. It starts at Canton, the great commercial centre of South China, and terminates at the frontier of the British leased territory of Kowloon by a junction with a very expensive and heavy section of railway 20 miles long that the Hongkong colony are constructing to complete the connection between Hongkong and Canton. In the future, if all goes well, by means of this railway Hongkong and Canton will be put in direct railway communication with Hankow, the future Clapham Junction of the great trunk lines of China, and thence with Pekin itself, so that before many years it should be possible to take a railway ticket at Victoria Station to Hongkong *viâ* Berlin, Moscow, Siberia, Pekin and Hankow.

The amount of the loan is £1,500,000, and although rather serious delays in getting possession of the necessary land have involved unnecessary expenditure, the railway is likely to be completed for the amount of the loan, or at any rate very nearly so.

When, after the signature of the final agreement for the construction of the Canton-Kowloon Railway negotiations were commenced in connection with the final agreement for the Tientsin-Pukow Railway loan, the Chinese Government demanded still further concessions from the financiers.

They agreed that the chief engineer should be an experienced European, but they insisted that he should be appointed by themselves, subject to reasonable approval, and that he should be under the orders of the Chinese managing director.

They would not consent to the appointment of a European accountant, and retain in their own hands complete control of the funds derived from the loan, subject only to the conditions that loan funds should be drawn upon on a requisition signed by the Chinese managing director, who is to certify for what the money is required. The bond-holders have the right to send a representative to examine the Chinese accounts at intervals.

The railway itself is not mortgaged as collateral security, as in the case of previous lines.

The amount of the loan was fixed at £5,000,000, the first issue being for £3,000,000 only, of which £1,890,000 was raised in Germany for the German section of the line 401 miles long, and £1,110,000 was raised in London for the construction of the British section, 235 miles long.

The total cost of the railway as estimated by German and British engineers for both sections was approximately £5,800,000, excluding interest payable during construction, which in this case is payable either from Chinese sources or from the proceeds of the loan at the pleasure of the Chinese Government, so that probably a further loan will have to be raised to complete the railway.

In England the loan was issued at 98¾ per cent., and was over-subscribed.

The principal work on this railway is a very important bridge over the Yellow River on the German section. It is too soon as yet to form a decided opinion as to the prospects of this railway. On the German section, at any rate, the work of construction is going on fairly smoothly. On the British section matters were not so satisfactory at first, but have, I believe, improved since. The Chinese methods of handling the loan funds gave cause for misgivings and complaint.

The last of the construction loans issued up to the present in this country is the Soochow-Hangchow-Ningpo Railway loan, the third of those for the construction of which a preliminary agreement was signed in October, 1898.

The Kiang Su and Chekiang provinces through which this railway runs are wealthy, and the local gentry are rich and enterprising. Fired with the laudable ambition to find the capital required for the building of railways in their own provinces out of their own pockets, the local gentry petitioned the central Government for permission to do so. Unfortunately the granting of the petition involved the cancelling of the agreement with British financiers that already existed. The central Government were thus placed in a serious predicament—they were afraid of refusing the

patriotic demands of the powerful provincial gentry on the one hand, and on the other, if they cancelled the concession they would lay themselves open to a charge of bad faith and give serious offence to the British Government. They appear to have thought that of the two courses open to them, the latter would follow the line of least resistance, but finding, as they did, their attempts to cancel the agreement aroused strenuous opposition, they next adopted an attitude of passive resistance to the settlement of the final agreement in order to gain time.

In the meantime two local Chinese Railway Companies were formed, the Chekiang Company and the Kiang Su, whose combined capital amounted to about £800,000, to construct the railway. These two companies were so ultra patriotic in principle that only Chinese were allowed to be shareholders, and no foreigner was to be employed by them. With £800,000 in their pockets, less than half what was required to complete the railway, they light-heartedly commenced to construct the railway on Chinese lines with Chinese engineers.

With regard to the qualifications of these engineers Dr. Morrison makes the following remarks in the *Times* of March 9th :—

"On the Kiang Su section the Chinese engineer in charge has only a rudimentary knowledge of railway construction; the engineer in charge of the Chekiang section is less incompetent, having been for one year at college in California. He is a son-in-law of the president of the company. One engineer in control of a section of twenty miles of railway has no engineering training, but owes his appointment to the fact that he was the favourite student of the president of the company, who is a well-known authority on the Analects of Confucius."

In face of this complicated state of affairs and with the additional obstacle of the antagonism of the local companies to face, it is not surprising that the British and Chinese Corporations found the negotiations for the final agreement difficult and tedious. At last, however, an agreement was arranged on the same lines as those of the Tientsin-Pukow Railway agreement already referred to, but interest during construction has to be paid from Chinese sources, and when in 1908 the loan was issued it was, like the previous one, over-subscribed in London.

When the Chinese Government signed the final agreement we must assume they intended to carry out its provisions, but that they have not done so is probably due to the fact that the local gentry have been too strong for them so far.

The money was lent to China on condition that the construction and control of the railway should be entirely vested in the Imperial Chinese Government; the local gentry have seen to it that the control is entirely vested in them. The Chinese Government appointed a managing director, but the local companies refuse to recognise him. The Chinese Government appointed, as they had agreed to do, a British chief engineer, but the local companies refuse to allow him to exercise his functions as chief engineer. The local companies having exhausted their own funds are now drawing upon the loan funds, and have done so in an irregular manner and contrary to the conditions of the loan agreement.

The class of railway that the companies are constructing is what might be expected under the circumstances. Dr. Morrison has fully described this in *The Times* already; it is unnecessary, therefore, to do so again now. From the point of view of an engineer the methods of construction adopted are often almost humorous, and as regards the supply of foreign material, it is perhaps hardly necessary to state that the clause of the loan contract which gives the British manufactures a preference has been honoured rather in the breach than in the observance.

So far as the bondholder is concerned, inasmuch as the Chinese Government have guaranteed his interest whether the railway pays or not, it does not perhaps much matter whether the money lent is being wasted, except that it is pretty certain that if the Chinese Government were to become responsible for many more railways of this kind they will find themselves unable to pay; I think, however, there is little doubt that the Chinese shareholders in the local companies may make up their minds to it that they have lost their money; in fact, I believe that many of them have made up their minds to this already.

The Chinese Government suffer most from this unfortunate state of affairs—not only the money for which they are responsible being wasted, but the principle of State ownership for all railways, so necessary for the best interest of China, is being violated; and lastly, but very far from least, the Chinese Government have been forced by uninformed and irresponsible provincial clamour into the position of having failed to uphold their reputation for reliability in the observance of their agree-

ments—a reputation so difficult to establish, so easy to lose.

In time, it is not impossible that the Chinese Government will regain control of this railway. They might have done so ere now had they not, in defiance of the agreement with the bondholders, made over the money lent to the local companies, and, if they do so, they may connect it with the Shanghai-Nanking Railway, and work the two railways together as one system, as was originally intended, and as ought to be done in the interests of the public and both railway systems; but much of the harm done in the meantime will be irreparable.

Although the last loan borrowed by the Chinese Government for railway construction was the Soochow-Hangchow-Ningpo Railway loan, they more recently borrowed, through the agency of the Hongkong and Shanghai Bank, £5,000,000 for general purposes, but more particularly for the purpose of repaying the Belgian loan of 1899 for the construction of the Pekin-Hankow Railway, and thus regaining full control of that railway. This was as usual borrowed at 5 per cent. interest guaranteed by the Chinese Government and was secured on the likin of the provinces of Chekiang, Kiangsu, Hupeh and Chihli.

Although the Chinese Government have now taken over the management of the Pekin-Hankow Railway they continue to employ expert European supervision where necessary, and the net receipts from that railway amount, I understand, to about £40,000 per annum, after having paid the interest on the loan.

The loan is repayable in thirty years, and the Chinese Government have already commenced to prepare for this by trying to raise in China a Government loan of 10,000,000 taels. The conditions of the proposed loan are very favourable—the interest guaranteed is 7 per cent.; bondholders are to share to the extent of 25 per cent. in the surplus receipts of the Pekin - Hankow Railway, and anyone who either subscribes himself or obtains subscriptions for large amounts is to be rewarded in money, or in money and official honours as well on a sliding scale according to the amount subscribed. So far there has been only a meagre response to this invitation, but whether the Chinese Government succeed or not in raising this internal loan it is difficult to appreciate the advantage they will gain by repaying a loan on which they have only to pay 5 per cent. with money raised on such far more onerous conditions.

Before concluding, the present condition of affairs in connection with the Hankow-Canton Railway calls for a few words. It will be remembered that the concession for the construction of this railway, the southern section of the great north to south trunk line of China, was originally granted to an American syndicate, who having done a certain amount of work, were bought out by the Chinese Government on terms mutually agreed between them, and that in order to get the money wherewith to pay off the American syndicate the Chinese Government borrowed from the Hongkong Government £1,100,000, an agreed condition being that in the event of it being found necessary to borrow capital from abroad for the construction of the Hankow-Canton Railway or the Hangkow-Chengtu Railway, British financiers should have the option of the business and British manufacturers the preference, on equal terms, for the supply of any materials ordered from abroad.

Before the American syndicate stopped work they had built in the neighbourhood of Canton a line of railway 30 miles long from Canton to the populous town of Samshui, and had also done a good deal of work on about 50 miles of the main line northwards from Canton. A local Chinese company was now formed at Canton to take over the work that had been done and to complete the main line northwards as far as the borders of the province of Kwantung, about 200 miles from Canton. The native company came into existence with great *éclat*; all sorts of promises were made to anyone patriotic enough to subscribe for shares, and a good deal of money was raised.

The Samshui line was taken over, and is being worked under Chinese supervision with an American traffic manager. For its length it carries an extraordinary passenger traffic which pays handsomely, but unless more is spent on maintenance, repairs, and renewals, it will hardly be able to maintain its record.

Construction of the main line northward was also taken in hand, and Mr. Wang, a Chinese engineer of ability and experience, was appointed chief engineer. Mr. Wang was educated in America, and had experience in railway construction under Mr. Kinder, on the Northern Railway. In the face of great difficulties inseparable from the conditions which govern the system of administration of Chinese railway companies, Mr. Wang is doing good work—ten miles have been entirely completed; on forty more the earthwork is complete and the rails laid; and the bridges are now being built. This portion of

the railway has been opened for traffic on temporary bridges whilst the permanent ones are being built Another seventy miles is under construction, but going on slowly, and the final survey is being made for the remaining length of railway, *i.e.*, to the northern border of the Kwangtung province. Whether sufficient money will be forthcoming locally to complete this railway, or whether it will have to be borrowed from abroad, remains to be seen. In the meantime, work in a desultory manner was taken in hand on the northern section of the main line, that is on about 500 miles that runs south from Hankow through the province of Hupeh and Hu-nan. Chang Chi Tung, the Viceroy, engaged a number of engineers, mostly Japanese, and seems to have hoped to build the railway somehow without having recourse to a foreign loan. Recently, however, it became obvious that if the railway was ever to be finished, money would have to be borrowed from abroad.

In the early part of this year, the Viceroy, Chang Chi Tung, invited the British and Chinese Corporation to advance £3,000,000 on what are now called the Tientsin-Pookow terms. These terms I have already described —they apply to both the Tientsin-Pookow Railway and also the Hangchow-Ningpo line.

Experience of these terms in the case of the latter line having been so unsatisfactory, and to a less degree in the case of the Tientsin-Pookow line, the British and Chinese Corporation, so far as they were concerned, were not prepared to accept them again, unless modifications were introduced which would give better assurance that the money to be advanced were properly spent on the work for which it was intended, and with due regard to economy.

A conference with Continental financiers was held, and it was understood that all were agreed that the modifications proposed by the British group were the minimum that it was safe to accept. In the meantime, the German group offered to accept Tientsin - Pookow terms. Chang Chi Tung therefore closed the bargain with them off-hand. His attention then was directed to the option he had promised when arranging the loan from the Hongkong Government.

There has been so much said and written lately, on this subject, that a compromise with the Germans and other nationalities concerned, appears to have been arrived at, which, at any rate, secures British interests so far as the Hankow-Canton Railway is concerned, even if at the expense of some of the recognised British interests in connection with the projected Hankow-Chengtu Railway. This compromise is perhaps likely to be hailed with chastened enthusiasm by a large number of people in this country, who are interested in China, but taking into consideration all the complicated and rather delicate circumstances of the case, it will probably be regarded by the majority as a reasonable solution of a difficult problem.

I have now come to the end of a very imperfect and superficial sketch of the history of the progress of railway development in China up to the present time. It is inevitably superficial, for I have attempted to condense the subject into as few words as possible, although I fear I have not escaped being tedious.

As to the future, I will not be guilty of the rashness of attempting to prophesy. We may, however, at least note the principal data upon which the problem of the future is based. It is certain that China is fully alive to the advantages of railways, and is now as anxious to build them as at first she was opposed to their construction.

That the Chinese railway system is in its infancy goes without saying. The railway system of India, for example, is only partially developed, but with a population of about 240,000,000 India can at least boast of about 30,000 miles of railway, whilst China, with a population greater by, perhaps, nearly 100,000,000, can at present show about 5,000 miles of railway only. Before Chinese railway development can compare with that of India another 30,000 miles or so will have to be built at a cost of, say, over £200,000,000 sterling.

Whether railways should be constructed by private enterprise in China, or whether the principle of State ownership should be universally adopted, is, perhaps, a matter of opinion. On this matter I think Mr. Kent puts it accurately when he says that State ownership is not only the best for China, but the only possible system compatible with success. Not only has experience so far demonstrated that Chinese railway companies are a mistake, but it would also be impossible to raise any large amount of capital by means of private companies in China. Private companies, too, would not have behind them the necessary power and authority which only the Government itself possesses. In private companies in China there would be too many private interests to be considered antagonistic to the interests of the undertaking and the Chinese

public. For these and many other reasons I think that the Chinese Government would do well to keep the construction of the railway system of the country in its own hands.

If the State is to take charge of the future development of the railway system of the Empire the question arises as to how they can raise the capital required. Can they raise it at home, and if not, can they raise it abroad?

There are many reasons why I think they cannot raise money in China. First and foremost money in China can command much higher interest than abroad. The Chinese capitalist regards 10 per cent. per annum as not a high rate of interest for a really safe investment, and gets his interest paid monthly. Sound native banks will borrow at this rate and lend it again themselves at anything up to 30 per cent., the maximum legal interest. It is hardly likely, therefore, that 5 per cent. railway bonds will appeal greatly to the Chinese capitalist; indeed, I much doubt whether the far more attractive terms that the Chinese Government are offering in the attempt they are now making to raise a loan of 10,000,000 taels, to which I referred before, will be successful in tempting the Chinese investor. There are other reasons as well, but I think the one I have mentioned is sufficient to prevent a Chinese Government 5 per cent. railway bond from ever being a popular investment in China itself, at any rate for many years to come. In several of the late loans, for example, subscriptions were invited in China as well as in England, yet, notwithstanding the fact that the Chinese Government guarantee had the additional advantage of being an undertaking to a foreign nation, no subscriptions were forthcoming in China.

The next question is, can China get the capital she requires from abroad? This is a question which could better be answered by a financier than by me, but I cannot help thinking she can on reasonable conditions.

It is true that the general financial position of China is being adversely criticised lately. I saw for example an article in the *Globe* on March 4th, in which it was stated that the foreign debt of China was £125,000,000 sterling, and that when the interest on this had been paid there only remained about £6,000,000 with which to meet the executive expenses of the Empire. If these figures are correct it is clear that China will have to find some new source of revenue before she can borrow much more money for railways. The railways themselves could be made to present the necessary source of revenue. I venture to believe that railways in China can be made to pay perhaps better than anywhere else in the world, but if railways are to be made to pay, first, all the money borrowed for them must be spent on the purpose for which it is borrowed and with due regard to economy and efficiency. Apropos of this it should be borne in mind that cheapness in first cost does not always mean economy. A flimsy railway not equal to the traffic it has to carry is not economical; cheap sleepers that have to be replaced every year or two are not economical; construction directed by inexperienced engineers is not economical, and a railway mismanaged when opened for traffic is the reverse of economical.

At present there are very few Chinese qualified railway officers. There are a certain number of able Chinese engineers no doubt—for example Mr. Jeme who built the Kalgan line, and Mr. Wang who is building the southern section of the Hankow-Canton Railway, but for many years to come there will not be enough men such as these to go round. In an engineer experience is even more important than theory, and reliable engineers take years to train.

There is little doubt, therefore, that for some time to come China will have to engage engineers from abroad to meet her requirements, and the same remarks apply to the senior officers of other railway departments. There is nothing derogatory to Chinese dignity in this. China has always been loyally served by the foreigners whom she has employed, and always will be. Their knowledge and experience in their own spheres have been, and will be, of the greatest benefit to her in every way; but if China is to be able to borrow the money she requires abroad, on the best terms, it will be necessary to cultivate the confidence of the foreign investor, a confidence which recent events have been calculated to shake.

What I venture to think is required is a strong and capable railway department or Board in Pekin, so constituted as to command the confidence of the foreign investor, and strong enough to command respect everywhere in China itself. The present Board of Communications falls short of this. Such a department would have its staff of expert assistants and inspectors, both Chinese and foreign, and would keep in touch with the administration of each railway, who would be responsible to the Board. The net earnings of all railways after payment of the cost of maintenance and renewals would

be paid to the Government Railway Department—the principles of its organisation might be somewhat similar to those of the Imperial Maritime Customs. A definite policy and a definite programme of railway construction should be laid down. To build up the revenues of the Board the best paying railways should be constructed first. The revenues and expenditure of the Board should be published. In time I think a Board so constituted would be able to raise loans on its general revenues, and pay off the various loans for the service of which the revenues of different existing railways are now hypothecated. To begin with, the Board ought to be able to show as revenue the surplus earnings of the Imperial railway of North China and of the Pekin-Hankow line, which (from information from Chinese sources, so far as the latter railway is concerned) amount, when taken together, to about £800,000.

DISCUSSION.

The CHAIRMAN (Sir John Wolfe-Barry, K.C.B.), in opening the discussion, said he was sure the audience would agree that in listening to the author, who was his nephew, and with whom he had been associated in much of his Chinese work, they had been listening to a man who knew his subject very thoroughly. It must be a great satisfaction to the Society that Mr. Barry had been able to attend and give such a detailed view of the great subject of railway communication in China, which all must recognise was one of the most important matters which lay before them in the future. The railway alone could effect the purpose of opening up of China to modern and western ideas It opened up an almost unknown land, and would affect the destinies of an enormous population and commerce. Still more profoundly would it modify the views of the Chinese themselves in respect to European ideas, and the views of Europe with regard to Chinese ideas; it would tend to bring Europe and China more and more together, greatly, he hoped, to the benefit of both. While stopping for a few minutes at a roadside station on the Great Eastern Railway in Essex the other day he was much struck by seeing on the wall a large advertisement saying, "You can take your ticket here, direct for Pekin and Japan *viâ* Harwich," a novel state of things which was somewhat startling to those who had not followed the development of Chinese railways. European interests were very large in the matter. First of all there were the financial interests represented by the great financial houses in London, Berlin, Paris and Brussels; there were also the interests of the bondholders, who were now putting very large sums of money into Chinese enterprises; and, lastly, it was necessary to consider the great importance of such matters to the manufacturing districts of the different countries which were interested in the development of China. In all those ways it must be realised that the various European nations were most keenly competitive; they were looking after the interests of their own nationalities; and he hoped that Great Britain would not be backward in taking their place in the financial ventures which were necessary for the development of China and of her manufactures. Looking to the future, as the author had pointed out, it seemed to be all important that no mistake should be made about the proper application of the money which the bondholders found. That was a matter which called for most careful attention, not only by the financial houses which brought out the loans, but also by the various Governments whose nationalities were interested in the great enterprises which lay before the coming generation. It must be clearly demonstrated that the money advanced was not wasted, but applied to enterprises which would be self-remunerative, and bring a safe return on the capital invested in them. While he looked at the subject to some extent from the inside, having been associated with many of the great undertakings to which the author had referred, he was also trying to take a more general view of the subject, and to point out how important it was that money that was put into Chinese industries should be carefully administered, for the good not merely of the bondholders, but of the Chinese themselves. Everyone wished to see China developed with railways in the same way that India had been developed, but he most cordially agreed with the author's remark that European control should be insisted upon as a guarantee, at least for many years to come. European control should not merely be exercised in the raising of money, but also in the application of it under responsible European technical advisers; and there should also be a board of management of all Chinese railways, similar to that which the Government of India had found it necessary to institute in that country. Under those circumstances he was persuaded there was a great future for Chinese railways. They ought, and could be made, to pay if properly and fairly constructed; and he thought it was possible to look forward to a great development in the future, which would be much more astonishing than that which had taken place within the last 15 or 20 years.

Mr. BYRON BRENAN, C.M.G., said the author had pointed out a great many mistakes which the Chinese had made; but it must be remembered also that mistakes had been made by the Europeans, who had been too much inclined to assume that the Chinese were keenly anxious to have railways, and that those who found the money, would be in a position to dictate their own terms. A different state of things was found when they came to put those assumptions into practice. A good many

the lines to which reference had been made would not be constructed within the lifetime of many present, but when they were, he thought the Chinese would be in a position to dictate the terms on which they would borrow the money; in fact the tendency was all that way at the present time, and the terms which were obtained from the Chinese eight years ago would never be obtained again. With regard to the desirability of having a Board of Management, it was possible it might come in time, but at the present moment the Chinese did not realise the necessity for it. He thought it would not be a bad thing to give the Chinese people plenty of rope, so that they would become thoroughly embarrassed in their financial arrangements, and then when they were in hopeless difficulties they might feel the necessity of reorganising the whole system. That might not come about immediately, but he believed before many years they would find great difficulty in paying the interest on their bonds out of the earnings of the railways; in fact, he doubted if a single railway was paying its way, excepting the Northern Railway from Tientsin to Pekin.

Mr. C. S. Addis said he had been particularly interested in Mr. Barry's *resumé* of the evolution of the demand for railways in China, which, he thought, formed part of a general quickening of the national life, and took its place along with the demand for education, Western luxury, and a development of the patriotic idea in the country. Yet, fired as the Chinese were by the national idea of China for the Chinese, they were unwilling to entrust the control of their railways to those with whose money they were constructed, and apparently equally averse from affording the necessary security. There was something pathetic in the way in which the Chinese Government of late had been scraping the national exchequer with a view to finding any source of security to offer instead of the railways themselves. It was just like the scene one was familiar with in China of the peasantry scraping the hills to find the necessary brushwood for their fires, and he was afraid, if allowed to go on, it would have the same result—China would be as denuded of credit as her hills were of trees. Mr. Brenan had suggested that perhaps the best cure for that was to give the country plenty of rope—to let her borrow as freely as she pleased, and give her as much control as she desired, until in course of time the ordinary financial drag would be applied, and she would find she could proceed no further. The objections to that plan, however, were so immediate, and it carried with it such a long delay in progress, that he believed the better course had been taken in coming to some sort of understanding, by which in future adequate guarantees would be given for the proper employment of the money. That seemed to him a good step in advance, and he thought that in itself was an augury which was fruitful of hope for the future. The next step which should be taken was, he thought, that the railways should be mortgaged as security to the foreign bondholder who, having paid the money, was entitled to some extent to call the tune. He was not without hope that that step also might be gained, and that when the independent sources of revenue became exhausted, or were required for other purposes, China might find there was nothing derogatory to the national dignity in pledging her railways in a way that was being repeatedly done by countries in the West. That might be assisted by the participation of Chinese subscribers in the railway loans. The author had alluded to one difficulty in that connection, namely, the much higher rate of interest which prevailed in China, but he did not regard that as a permanent feature. Interest was high in China because the security was bad, and as the security improved he believed, *pro tanto*, the level of interest would diminish. He associated himself with the author's remarks with regard to the *personnel* of the railway, and he believed it was one that no responsible financier would desire to combat; on the contrary, it was the desire of those connected with railways to encourage and assist China in every way in entering into her own inheritance. But as the author had insisted, the best way was to begin with a strong leaven at least of higher foreign officials, in the same way as in the Imperial Maritime Customs. Then, there was required a school of engineering, by which the Chinese would be gradually educated to take their proper place in the construction of the railways. With regard to the future, when one thought of the cumulative effect of the increase of inter-communication in China, the prevention of famine, and the improvement in social intercourse it would entail, one might look forward hopefully. The author at any rate, could look back with satisfaction upon his share in the work, and with confidence to the share which every one hoped he would take in it in the future.

Colonel E. St. C. Pemberton, R.E., thought some councils of perfection with regard to what was desirable had been given by previous speakers, very few of which would work out in the way hoped for. There was no doubt that the control of the railways was most desirable, but he agreed with Mr. Brenan that it was hardly likely that, in years to come, the Chinese Government would look favourably upon any efforts of other countries to secure control over the lines that might be built with foreign capital. It was a most advantageous circumstance that the solidarity of the European communities and financial interests in China had been recognised by the countries concerned, and that steps were being taken in Pekin to bring combined pressure on the Government to give more favourable terms as to guarantees of the loans. As long as that state of things existed there would be an amelioration in the terms, but it was doubtful in the future

whether the political condition of things in the metropolis of China would allow it to continue. He thought railways would be built more rapidly than many Europeans considered likely. The experience of the world during the last quarter of a century had shown that no country could be developed, certainly not rapidly, unless a network of railways was gradually spread over it. That had been shown to be the case in British Columbia and South Africa. The Chinese now had the experience of the rest of the world to go upon, and fully recognised the necessity of building railways. Those railways would rapidly be built, although it was another question whether they would be carried out to the entire satisfaction and advantage of the shareholders in European countries who enjoyed the guarantee of the Chinese Government. It would be a very singular thing if the railways in China did not pay, considering the many resources and huge population in the country. If the railways paid more, would be built, in fact they would be speedily built, whether they paid or not. The construction of the railways would react on the situation and development of the country, by means of the fact that the authority of the central Government at Pekin would be enormously increased and enhanced by the spread of the means of control; and with that increase of control the methods of construction of fresh lines and branches in the outlying districts would be put upon a better footing, because the provincial authorities would not be able to act as they had recently been doing at Shanghai on the Ningpo line. He had recently travelled through China for some months, and had come home feeling quite convinced in his own mind that there was a splendid future for the railways in that Empire. He hoped China would be able to construct her railways without getting into financial difficulties, and he thought that would probably be the case.

Mr. J. W. Jamieson said that the period of time covered by the paper was contemporary with his own service in China. He remembered the first line of railway, to which the author had referred, being put down and pulled up again, the waggons, rails, and engines being sent by steamer to Formosa, where they were dumped on the strand, and left to disappear in mother earth. The great railway development occurred just after the Chino-Japanese war, when he remembered the Director-General of Railways making several enquiries from him, as to who were the best people with whom to negotiate loans; and if Messrs. Jardine, Matheson and Co. had been a little more diplomatic, he thought they might have received the concessiom for the first railway, the Hankow-Pekin, which eventually went to the Belgians. Up to a certain point the railway development was quite satisfactory, but he thought the Chinese would have been well advised if they had given a substantial concession for a period of years on terms that would have been sufficiently tempting and remunerative to a sound foreign syndicate, and left it in their hands. If the Chinese had put their pride in their pockets, and trusted themselves in the hands of the foreigner, the railways would have been better constructed and better managed, and at the end of the period the Government would have obtained a sound going concern on reasonably equitable terms. In that way they would not have been called upon to handle the railways until they had been trained for the purpose, and were able to do justice to them. Unfortunately a new spirit had sprung up lately; and although he quite understood it and in a sense sympathised with it, he looked forward with considerable apprehension to what would happen in the future. He thought the Chinese had difficulties ahead of them for a good many years to come. He doubted whether, with the exception of the Northern Railway, a single railway was paying very much. No accounts had been published of the Pekin-Hankow Railway, with regard to which it was said two years ago that a profit had been made, but he recently read in a Chinese paper that, on the contrary, the Government had been called upon to make up a deficit. The Government was paying away money all round, and the income derived from it was not yet sufficient to meet the demands. The country was developing but slowly, and very careful nursing would be required to take it safely through the next ten or fifteen years. He did not wish to be in the least alarmist in his remarks, because he thought any railway in China which was properly located, would pay in the long run, although it would not pay 5 per cent. at the beginning. It was his opinion that the Chinese Government were going ahead at the present moment as fast as it was wise they should do.

On the motion of the Chairman, a hearty vote of thanks was accorded to Mr. Barry for his interesting and instructive paper, which Mr. Barry briefly acknowledged, and the meeting terminated.

WOMEN'S LIFE AND EMPLOYMENT.

In a paper read recently before the Royal Statistical Society, Miss B. L. Hutchins gave some interesting statistics of women's life and employment. At the census of 1901 women were 1,070,000 in excess of men, the ratio per 1,000 persons having steadily risen from 511 in 1841 to 516 in 1901. During the preceding decade the average duration of life was 44·13 for males and 47·77 for females, and the superiority of the female life had become more marked at each successive period since 1838. It appeared that, though physically weaker, women had a more tenacious hold on life than men. In the rural districts they were in excess from the age of [illegible] only, but in urban districts from the second year onwards. The number of boys born was somewhat

greater than that of girls; any reduction, therefore, in infant mortality automatically tended to increase the relative number of boys surviving. The healthier districts are thus helping to restore the balance, and to illustrate this point certain "unhealthy" and "healthy" counties were selected, showing that in the latter a higher proportion of boys survived.

How was this excess of female population provided for? Marriage was still the most extensively followed occupation of women, including over 5,700,000, or nearly half the female population over 15. Marriage might be supposed to provide for about three-fourths of women between the ages of 35 and 55. Before 35 and after 55 a large proportion were not thus provided for. The proportion of women and girls over 15 in 1901 returned as occupied was 34·5 per hundred living. The employment of single women was largely an episode of early life, girls' work being for the most part a "meanwhile employment." Woman was normally provided for by marriage for twenty or thirty years only, and this break in her life, and her return to competitive work in later life after a long interval, were among the chief causes of pauperism. The number of widowed, occupied or otherwise, was connected with the male death-rate. The toleration of preventable disease and accidents must create pauperism, and thus illustrated the saying that we could have as many paupers as we liked to pay for. Many more single women than married or widowed were returned as living on their own means, owing, no doubt, to the greater frequency of marriage among the poorer classes.

Details were given of the special conditions existing in Lancashire, where 38·7 per cent. of the women of all age over 10 were returned as employed. In Lancashire, 76 per cent. of the girls aged 15-20 were returned as against 65·9 for England and Wales. Between 20 and 25, the percentages were 64·9 as against 56·3. In Blackburn, 40 per cent. of the girls between 15 and 25 were occupied; and the demand for young girls' labour was increasing both in textile and non-textile work. 23·5 per cent. of women occupied in textiles were married or widowed. This fact was doubtless related to the high rate of infant mortality in Lancashire, but it was noted that the mortality of all ages for both men and women was much higher there than in England and Wales generally. A large part of the excess mortality was caused by respiratory and other diseases largely preventable, and due to unhealthy conditions of work or housing.

The number of women and girls returned as domestic servants in England and Wales was 1,285,000, of whom 35 per cent. were under 20. The German Empire, with a population of 56,000,000, contained fewer servants than England and Wales. Unfortunately, no material existed for estimating the number of women occupied with the care of children, whether as mothers or nurses.

Women were still the largest class of paupers, but in a decreasing proportion. Under the system of recording paupers by the year instead of by the day, the number of women receiving relief was smaller, both in London and in Lancashire, than the number of men. The figures for pauperism as a whole indicated that improved education and opportunity were rendering women more independent and self-reliant than formerly.

Women had a less task in industry than men, but beyond their industrial work, they often did an enormous amount of work at home, without outside help, in addition to the bearing and rearing of children. Considering these facts, and remembering also that the wife and mother was the first person of the household to feel the stress of want, the lower death-rate of women could not be explained as the result of privilege and protection.

BOOKS ON WATERMARKS.

NOT INCLUDED IN LIST PUBLISHED IN THE "JOURNAL," JANUARY 29TH, 1909.

(Compiled by Herr Hofrath Franz Bartsch.)

1862. Cohendy, M. Note sur la Papeterie D'Auvergne anter. à 1790 et les marques de fabrique des papeteries. Extr. des Mémoires de l'Académie de Clermont. 41 water-marks.

1882. Schiffmann, F. J. Die Wasserzeichen der datirten Münsterer-drucke als Zeugen für die Aechtheit eines undatirten. In Jahrbuch f. schweizerische Geschichte, Bd. 7. 9 water-marks.

1883. Geschichtsquellen der Provinz Sachsen Bd. XV. bearb. von Dr. Jacobs. 4 water-marks.

1888. Richard, J. M. Filigranes de papiers de la première moitié du XIV. siècle, conservés au Tresor des chartes d'Artois à Arras in Bulletin Archéologique du comité des travaux historiques. 54 water-marks.

1888. Secher, V. A. Fortegnelse over 235 Prover paa skiv papirsorter brugte af den Danske Admenistration fra den 15 til det 19 aarhundrede. 10 water-marks.

1889. Marabini, E. Die Wasserzeichen in Büttenpapieren des 14-19 Jahrhunderts. Alterthumsvereins München. 34 water-marks.

1889. Boudon, G. Notes sur quelques filigranes de papiers des XIV., XV. siècles et de la première moitié du XVI. Société des Antiquaires de Picardie. 37 water-marks.

1892. Briquet, C. M. Sur les papiers usités en siècle. Extr. Archivio storico Siciliano N.S. anno XVII. 41 water-marks.

1892. Les Caproni fabricants de Papier à la Serraz au XVII. et XVIII. siècle. Leur marques et filigranes par A. Perrin. 124 water-marks.

1896. Piekosinki Fr. Wybor znaków wodnych z XV. stulecia Estr. "Wiadomosici numizmatyczno-archologiczne." 1119 water-marks.

1897. I segni delle cartiere di colle di A. Lisini. Estr. Miscellanea storica della Valdelsa. 28 water-marks.

1897. Gautier, J. L'Industrie du papier dans les

hautes vallées franc-comtoises du XV. et XVIII. siècle. Extr. des Mémoires de la Société d' Emulation de Montbeliard.

1897. Bösch, Hans. Die Hohenzollern und die Papierfabrikation in Franken. Papierzietung, Berlin. 10 water-marks.

1897. Keinz, Friedr. Ueber die älteren Wasserzeichen des Papieres und ihre Untersuchung. Zeitschrift für Bücherfreunde. 11 water-marks.

1898. Briquet, C. M. Les Anciennes Papeteries du Duché de Bar. et quelques filigranes Barrois de la seconde moitié du XV. siècle. Extr. du Bibliographe moderne 1898. 8 water-marks.

1898. Devaulx, Th. Filigranes (marches de papier). Revue des arts decoratifs, Janvier. 28 water-marks.

1901. D. francesco de Bofaruly Sans. La heraldica en la filigrana del papel. 30 water-marks.

1903. Gollob, Ed. Verzeichniss der griechischen Handschriften in Oesterreich auszerhalb Wiens. Sitzungsberichte. der kais. Akademie der Wissenschaften in Wien phil. hist. Clas. 60 water-marks.

1905. Illig'sche Wasserzeichen aus Büdingen-Papierzeitung Berlin vol. 5. 7 water-marks.

1905. Hasselquist, Alexis. Vattermärken i. handgjardt papper. Allmànna svenska bocktryckareföreningens meddelanden H. 20 7. 44 water-marks.

1906. Moutailler, G. Memento des filigranes ou marques de papiers des 13, 14 et 15 siècles. Numerous water-marks.

1906. Würtembergische, Wasserzeichen. Papierzeitung Berlin H 100. 7 water-marks.

1906. Hössle, Friedr. v. Die Ulmer Papiermühle. Papierzeitung Berlin H. 102. 8 water-marks.

1907. Walter, C. F. Papierfabriken Flensburg. Wochenblatt für Papierfabrikation. Vol. 14. 3 water-marks.

1908. Hössle, Friedr. v. Die Papiermühlen im Bayrischen Allgaü. Wochenblatt für Papierfabrikation. Vol. 25. 116 water-marks.

1900. Hössle, Friedr. v. Geschichte der alten Papiermühlen im ehem. Stift Kempten und in der Reichstadt Kempten. Numerous water-marks.

1908. Szönyi, J. L. 14 szazadbeli papiros-oklevelеink vizjegye. (Marks on 14· cent. papers.) 223 water-marks.

THE REFRACTORY CLAY PRODUCTS INDUSTRY IN BELGIUM.

Refractory clay products are largely consumed in Belgium by the metallurgical industries, the glass works, the manufactures of porcelain, and in general all those industries where the work is carried on through the medium of heat at an especially high temperature. The manufacturer of refractory clay products utilises a special kind of earth of which there are large deposits in the neighbourhood of Liège, and in more limited quantities in the district lying between the Sambre and Meuse. The manufacture of refractory clay products has been subject to alternate periods of activity and depression, following to a great extent fluctuations in the glass and metallurgical industries. In 1899, a year of marked industrial prosperity, the manufacture of this class of products reached its maximum development. At the beginning of 1901 prices began to decline, and remained exceedingly low until 1904. For some years the situation has remained rather unsatisfactory for a certain number of factories not sustained by large amounts of capital. At the present time, however, in comparison with other industries of the country, that of the manufacture of refractory products is, it is asserted, in a fairly prosperous condition. The factories, as a general rule, are established near the deposits of plastic earth needed, and at the same time in as close proximity as possible to the centres of the coal-producing industries, while in many cases they are found in the vicinity of the metallurgical establishments, glass works, and other industries that utilise refractory products. The American Consul at Liège says that many factories are found in the province of Namur, at Andenne, Seilles, Floreffe, Wierde, and Florennes, and in the province of Hainault at Baudour, Hautrages, Sirault, Saint Ghislain, Stambruges, Chatelet Jumet, Roux, Marchienne au Pont, Marcinelle and Forges. There are other factories at Angleur and Ampsin. The refractory products most generally manufactured are bricks of the class known as "briques courants," other classes of brick and pieces of special construction and composition designed for various industrial uses, for the metallurgical industries, glass works and chemical industries. The manufacturers of refractory products, in reality, only furnish a part of those products utilised in the different industries. About one-third of the fire-clay products manufactured by those establishments that do not form an integral part of other industries, is exported. Among the exported products, those that figure most extensively are fire bricks for blast furnaces and glass works, gas retorts, &c. The principal countries to which the products of this industry are exported are England, France, Germany, Holland, Russia, Switzerland, Spain, Portugal, Italy, Brazil, the Argentine Republic and Mexico. Exports to Russia, which were of considerable magnitude some years ago, fell off to a large extent when a period of general industrial depression prevailed in that country, and they have been constantly decreasing ever since. Exports to France steadily decreased up to the year 1905, owing in part to the import duties and the creation by Belgian capitalists of three factories for the manufacture of refractory products in the north of France. The industry of the extraction of refractory clay in the basin of Andenne and Bandour is an industry which has continued to exist under most prosperous conditions. Besides the exports of plastic clay, Belgium furnishes dolomite and lime for a great number of the steel works of Rhenish Prussia, the Grand Duchy of Luxembourg, Lorraine, and the north of France.

HOME INDUSTRIES.

The Meat Supply.—The Report of the Departmental Committee appointed to inquire into combinations in the meat trade shows, *inter alia*, that the dependence of the United Kingdom on foreign supplies, although it has tended to increase in recent years, has not done so very rapidly. In 1898-9, the home supplies were 55·0 per cent. of the total supplies; in 1907-8 they were 54·0 per cent. The percentage of beef and veal fell from 63·3 to 60·8, and of mutton and lamb from 61·2 to 55·9, but the percentage of pig meat rose from 38·1 to 43·1. But the proportion of home to foreign meat varies very widely in different markets. For example, at Dundee, Newcastle, and Norwich, almost the whole of the supply comes from home sources. On the other hand, a large part of the meat supply of Glasgow is drawn from abroad; about two-thirds of the meat which comes into Manchester is of foreign origin, and at Smithfield it reaches no less than 80 per cent. Only 1 lb. in 5 lbs. of the meat sold in that market is home-grown. Taking the last decade, the average annual amount of the supplies of home-grown meat was 25,035,000 cwts., the maximum being 26,063,000 cwts. in 1899-1900, and the minimum 23,705,000 in the preceding year, the amount for 1907-8 being 25,313,000 cwts., or rather above the average for the previous nine years. The increased demand, due to the growth of population, and an advance in the standard of consumption, has been met by a rising importation. The importation of live animals has, except in the case of cattle, almost disappeared, and in the last three years the importation of cattle has tended to diminish. The imports of chilled and foreign beef, on the other hand, have increased very largely, although for the four years, 1905-8, they show but little change. American beef is chilled, and so is a large and increasing part of that from the Argentine, but the distance from Australasia to the United Kingdom renders recourse to freezing necessary. The best American chilled beef has commanded a higher price than the best English beef, and than some qualities of Scotch beef; Argentine chilled beef ranks lower but great efforts are being made by Argentine cattle-rearers to improve their stock. The most striking feature in connection with the meat imports of recent years is, perhaps, the rapid advance made by the Argentine Republic, and the fact that in the last four years it has taken the place of the United States as the principal source of supply. The supply from the United States is likely to diminish owing to the growing home demand.

British Ports Expansion.—The new port authority for London is now well under weigh and it may be expected that vigorous steps will be taken to ensure the maintenance of that Port supremacy enjoyed by Londoners for many generations. In recent years there has been unprecedented development of harbour accommodation, and in some respects provincial ports show greater improvement than the Thames. The first want of the modern port is depth of water. The length and breadth of ships have been extended much more than increase in depth but deeper draught is not to be avoided. The importance of this to the Atlantic liner will be understood when it is remembered that on an average draught a liner of 23,000 tons can carry only from 500 to 600 tons of cargo, whereas an increase of one foot in her draught would enable her to carry 1,600 tons, and a two feet increase 2,500 tons, with very little loss in speed. At Southampton the entrance channel to the port has been deepened to a depth of 35 feet, and there are graving-docks over 850 feet long, 88 feet wide, and with entrances of 80 feet breadth, besides other smaller docks and shipways. At Bristol the Royal Avonmouth Dock was constructed at a cost of £3,500,000; Cardiff followed suit with the Queen Alexandra Dock, and in October the Swansea Harbour Trustees expect to open one of the largest docks yet built, with an area of 60 acres, and Port Talbot, Newport, and Barry near by are active in providing new facilities for shipping. The whole of the dock system on both sides of the Mersey has been revised, and the Mersey Docks and Harbour Board have a £3,000,000 scheme in hand, while at Garston a large dock has just been opened. At the Hartlepools, Blyth, and Middlesbrough dock accommodation has developed immensely, and the Tyne Improvement Commissioners are untiring in improving the port of Newcastle. Nor is Scotland behindhand, for great works have been and are being constructed for deepening the Clyde channel, and there are now over 220 acres of water space at Glasgow where vessels drawing over 30 feet of water can be accommodated.

The Small Holdings Act.—Wherever the fault may be, it must be admitted that, notwithstanding very numerous applications, the number of small holdings actually created under the Act is very low, being only about 4 per cent. of the approved applications. It must, of course, be remembered that the Act has been in operation for little more than sixteen months, and that the first six months were really a period of preparation and investigation. It must be admitted, too, that the rate of progress is quickening. In the first six months 23,000 applications for small holdings were received, but only 1,406 acres were acquired, and only one compulsory order was made. In the second six months 17,090 acres were acquired and eleven compulsory orders were made. During the first four months of the present year 11,754 acres were acquired, and forty-one compulsory orders were applied for, so that as time goes on the amount of land acquired for the purpose of small holdings is growing. But even at the present accelerated rate many years must elapse before any great change can be effected in the ownership of the land. And it is difficult to avoid the conclusion that the local authority is in some counties much less sympathetic than it might be

For example, in the recent debate in the House of Commons it was officially admitted that in Surrey only 10 acres have been acquired, in Sussex five, and in Cardigan and Flintshire none. Yet in Surrey there had been 114 applicants, of whom 56 had been approved; in Cardigan there were 129 approved applicants, and 2,096 acres asked for; and in Flintshire 1,400 acres had been applied for. Clearly some county councils are sluggish in the matter, and there is ground for thinking that the requirements of the Board of Agriculture in regard to the share capital of co-operative societies for the acquisition of small holdings are over rigid.

The Sweated Industries Bill.—It is satisfactory to find that among the larger manufacturers of ready-made garments there is a general disposition to welcome the Sweated Industries Bill. They say that smaller rivals, with inferior productive facilities, seek to reduce their cost by cutting down wages, whilst the wage-sheets of leading producers show that the sweating evil does not accompany minimum cost of production, but often connotes waste and incompetency in productive methods. As to State interference raising the cost of production and inducing the importation of cheap foreign goods, it is pointed out that the British exports of "apparel" have of late years approximated in value to £6,000,000 per annum, exclusive of hats and bonnets. But it would be unwise to expect very much from the mere enforcement of a minimum wage. It may well prove in many cases the transforming of the woman into the main supporter of the family, leaving the man to accept even worse pay or more casual conditions. Moreover, if the principle of the living wage means anything, it means not only a minimum wage but also a minimum continuity of employment. Of what avails it that the worker gets a better rate per hour unless the average number of hours per week and weeks in a year, is maintained at a certain level?

CORRESPONDENCE.

DEW-PONDS.

In the issue of *Nature* of the 13th inst., Mr. J. B. Cohen writes under the above heading saying that he has always been sceptical about the theory of dew-ponds since my brother and I published "Neolithic Dew-ponds and Cattleways."

Mr. Cohen's experience is "that lakes and ponds lose their heat slowly, and that after radiation has set in at night they indicate a much higher temperature than the ground adjoining, or the air above." And in proof of this Mr. Cohen observes that "on Coniston Lake in summer, after a night of heavy dew, the bottoms of the boats inside were perfectly dry, whilst the gunwale was covered with moisture, showing that the portion of the boat in contact with the water had been raised in temperature above the dew-point."

Mr. Cohen has also found that the temperature of the water of a dew-pond is above the temperature of the air. "It is impossible, therefore," he says, "that dew could deposit on the ponds under these conditions."

Mr. Cohen, like Mr. E. A. Martin, seems to be satisfied by taking the comparative temperatures of the water and the air. I may repeat that I have before attempted to explain, that it is not the temperature of the bulk of the water that, in my opinion, regulates the deposition of dew, it is the temperature of the surface film of water which is alone involved, and this is not readable on the scale of an ordinary thermometer.

The results obtained by Mr. Cohen and Mr. Martin appear to me to be on this account purely negative.

"E. A. M." is quoted as pointing out "that it is inconceivable that the clay or straw in a full dew-pond can have much connection with the temperature of the water." I do not know to what "much connection" may amount, but from my own experiments with a non-conductor of heat, it makes all the difference between the presence or absence of dew deposition. This was curiously exemplified in a pond constructed by my brother and myself, where we used square slabs of waste mica. The slabs were two feet square and two inches thick. The upper surface of the slabs after they were laid was coated with a uniform layer of asphalte. The asphalte ran in between the edges of the mica blocks, so that the seams of mica were disconnected from each other by a thickness of about ¾ inch of asphalte. When the hoar frost lay upon the ground a curious spectacle presented itself. On the upper surface of the coating of asphalte the hoar frost was deposited in squares precisely corresponding to the area of the square mica slabs below. The surface of the asphalte lying above the joints showed no signs of hoar frost and remained black. The pond in fact presented the appearance of a beautiful chess-board with all white squares and black lines between them. This experiment was a very striking example of the effects of a good non-conductor of heat when used in the construction of a dew-pond. GEORGE HUBBARD.

112, Fenchurch-street, E.C.
19 May, 1909.

QUESTIONS AND ANSWERS.

NOTICES TO CORRESPONDENTS.

Readers in search of information which cannot be obtained from the usual sources are invited to make their wants known in the *Journal*, in the hope that they may be assisted in their difficulties by their fellow members.

On all communications must be written the name

and address of the sender, not necessarily for publication, but as a guarantee of good faith.

Each question or reply should be written on a separate sheet of paper, and should bear such signature of the writer and such address as he wishes to appear.

Questions which can be answered from the usual books of reference, will not be printed.

QUESTIONS.

Cacao Beetle.—Can any member inform me as to the best means of exterminating the cacao beetle? —Planter.

Gourds as Wild Duck Decoys.—I have seen it stated that the natives of Venezuela employ gourds as wild duck decoys. Where can I find a description of the manner in which they are used?—W. M.

ANSWERS.

Portland Cement and Lime.—I can say from experience that the following mixture will make a hard plaster for internal walls of public buildings, or where a hard plaster is required: ½ cubic yard of putty lime, ½ cubic yard of sharp sand, 1 bag (2 cwt.) of Portland cement. Portland cement is used instead of Plaster of Paris for gauged work in some parts of the country, the putty being made from burnt limestone. If too much Portland cement be used the plaster will crack.—John S. Chenhall.

Wax for Modelling Purposes. — Bees'-wax has been used for modelling purposes for at least 4,000 years; but specimens of so great an age are naturally rare. In the Berlin Museum of Antiquities, however, there are several objects modelled in wax which were found in an ancient Egyptian tomb, and are in an excellent state of preservation. A head of Osiris, especially, is modelled with the most intricate detail, and is an excellent example of the art of those far-off times. There are also two heads of sons of Osiris and a scarab, all modelled in unbleached bees'-wax. If the portraits in "Cera's" possession are of public personages it might be possible to identify one or more of them, and thus fix their maximum age.—Walter F. Reid.

NOTES ON BOOKS.

The Destruction of Daylight. By John W. Graham, M.A. London: George Allen. 2s. 6d. net.

This little work, which is described by the author as "a study in the smoke problem," is addressed not to the smoke expert, for it makes no pretence as to original research in chemistry or engineering, but to the manufacturer and the citizen in whose hands, according to Mr. Graham, the remedy lies. "The engineers have provided for every case smokeless, or nearly smokeless, devices . . . . . it is now for the public to amend and, above all, to enforce the law." As the human race has no greater benefactor than the sun, so it has no worse enemy than fog. It is, of course, impossible to estimate in anything but the roundest of figures the loss inflicted on us by smoke and fog, but many people will be surprised to learn that the Hon. Rollo Russell, after careful observation and consideration of the various kinds of damage done, set down the cost in 1888 to London alone as well over five million pounds. The damage to health it is impossible to reckon in coin of the realm. Nor is the blight limited to the towns themselves. At Kew Sir William Thiselton Dyer estimates the solid deposit at nearly two tons per acre per annum; at Richmond there is "a thick black deposit on the leaves of trees;" the moors in Derbyshire are dirty to sit down upon, and the sheep there are grimy in colour, while even the Lake District is not entirely free. Mr. Graham has had no difficulty in the first part of his book in making out his case for pure air and sunshine, and the latter part contains a useful account of the various means by which the smoke-fiend may be successfully combated.

The Bell Telephone. Boston: American Bell Telephone Co. 1908.

Before the expiry, by lapse of time, of the United States patent granted, in 1876, to Alexander Graham Bell, for his invention of the telephone, it was naturally the subject of a good deal of litigation in the American law courts. In the various cases, Mr. Bell was a very important witness, and gave a large amount of evidence. This evidence was collected into the form of a deposition made by him in the last case, commenced in 1887, but never carried to an issue. In view of the historical importance and the scientific value of the information contained in it, this deposition has been printed and published by the American Bell Telephone Company. It is a voluminous record of the early history of the telephone, given, of course, from the standpoint of the inventor, and as such cannot fail to have considerable permanent value.

GENERAL NOTES.

Viticulture in Afghanistan.—Information has reached India that the attention of the Amir has been directed to the possibility of growing vines for wine making, and that an expert is now investigating the question of opening up a wine industry on a large scale in Afghanistan. It is a fruit-producing country of some importance, as many Central Asian regions are, and the grapes in particular are known to be of excellent quality. The Indian journal, however, that makes this announcement points out that with over-production of claret in France, and with no facilities for transport in Afghanistan, it is unlikely that Afghan wine could

compete with the product of the great wine-producing countries of the West. There is no doubt that the Amir's known repugnance to railways is largely responsible for the backward state of the trade and development of his dominions. At the same time, it must be borne in mind that road-trains are an invention that bid fair to play a most important part in the opening up of semi-exploited regions, such as Persia, Baluchistan, and Afghanistan. They have been employed with great success in India, and where the cost of a railway is prohibitive, a far cheaper means of communication is for an average road to be laid down, and a few motors, carriages, and trucks to be run along it at regular intervals. Considering how successful breweries have proved in India, there seems no reason why wine should not at least secure a fair trial.

COTTON GROWING IN EGYPT.—In his annual report upon Egypt and the Soudan, just published, Sir Eldon Gorst refers to the cotton position in Egypt, and shows that the expectation of having a large increase in the cotton exports of that country are not likely to be realised. The area under cotton in 1908 exceeded that of the previous year by 37,191 feddans, the greater part of the increase being in the newly-converted basins of Middle Egypt, but the total output was only 6,250,000 kantars, as against 7,172,191 kantars last year. Recent returns show that the total production of cotton in Egypt is not increasing in the same proportion as the cotton-bearing area. This is partly explained by the fact that this area comprises a considerable quantity of land only recently put under cultivation, from which heavy crops cannot at first be expected, but there seems no doubt that a real falling off in the yield has occurred in some parts of Lower Egypt. A Commission was appointed last year to consider the causes of this diminution, and in its report various reasons are given, among them deterioration of soil caused by (1) the system of planting cotton every second year; (2) insufficient irrigation, which will be remedied by the heightening of the Assouan dam; (3) insufficient drainage which has caused a gradual rise in the level of the water in the subsoil to the detriment of the crops; (4) deterioration of the plant; (5) decrease in manuring, due to the quantity of natural manure available; and, (6) one of the principal causes of damage, insects and worms favoured by the recent practice of planting cotton every second year. In 1905-6 a special staff was appointed to assist the provincial authorities in executing the prescriptions of the law of 1905 for the destruction of the cotton worm, but last year it was thought that the local authorities would have learnt how to carry out the measures without special assistance from headquarters. The experience of the year has shown that it is useless to rely on the initiative or energy of the landowners, either great or small, even in a matter which so vitally affects their own pockets, and in future the former practice of creating a special service for the work will be revived.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoon, at 4 o'clock :—

MAY 26.—"The Manufacture of Nitrates from the Atmosphere by the Electric Arc." By HERR SAM EYDE, of Christiania, Norway. PROFESSOR SILVANUS P. THOMPSON, D.Sc., F.R.S., will preside.

INDIAN SECTION.

Thursday afternoon, at 4.30 o'clock :—

MAY 27.—"The Function of Schools of Art in India." By CECIL L. BURNS, Principal of the Bombay School of Art. PROFESSOR SIR HUBERT VON HERKOMER, C.V.O., D.C.L., R.A., will preside.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 24...East India Association, Caxton-hall. Westminster, S.W., 4½ p.m. Sir Robert Fulton, "The Judicial Branch of the Indian Civil Service."

Surveyors, 12, Great George-street, S.W., 5 p.m. Annual Meeting.

TUESDAY, MAY 25...Royal Institution, Albemarle-street, W., 3 p.m. Professor John Garstang, "The Hittites (2): Recent Discoveries in Asia Minor and Northern Syria."

WEDNESDAY, MAY 26...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4 p.m. Herr Sam Eyde, "The Manufacture of Nitrates from the Atmosphere by the Electric Arc."

United Service Institution, Whitehall, S.W., 3 p.m. Dr. T. Miller Maguire, "National Recuperation."

Eugenics Education Society, Caxton-hall, Westminster, S.W., 8½ p.m. Sir Henry Cunynghame, "Alcoholism."

THURSDAY, MAY 27...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Mr. Cecil L. Burns, "The Function of Schools of Art in India."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. John G. Millais, "Newfoundland." (Lecture III.)

FRIDAY, MAY 28...Royal Institution, Albemarle-street, W., 9 p.m. Dr. J. Emerson Reynolds. "Advances in our Knowledge of Silicon as an Organic Element."

SATURDAY, MAY 29...Royal Institution, Albemarle-street, W., 3 p.m. Dr. W. H. R. Rivers, "The Secret Societies of the Banks' Islands." (Lecture II.)

ERRATUM.—Mr. John Ferguson, C.M.G., asks that the following correction may be made in the report of his speech during the discussion on Mr. S H. Fremantle's paper, "The Problem of Indian Labour Supply":—p. 522, col. 2, line 34-36—in the sentence, "Ceylon paid India now nearly four million pounds sterling a year for this [rice];" for the word "four," *read* "two."

Journal of the Royal Society of Arts.

No. 2,949. VOL. LVII.

FRIDAY, MAY 28, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

INDIAN SECTION.

On Thursday afternoon, May 27th, Mr. CECIL L. BURNS, Principal of the Bombay School of Art, read a paper on "The Function of Schools of Art in India." PROFESSOR SIR HUBERT VON HERKOMER, C.V.O., D.C.L., R.A., presided.

The paper and discussion will be published in a subsequent number of the *Journal.*

CONVERSAZIONE.

The Society's Conversazione this year will take place at the Natural History Museum, Cromwell-road, S.W. (by permission of the Trustees of the British Museum), on Tuesday, June 29th, from 9 p.m. to 12.

Each member is entitled to a card for himself (which will not be transferable) and a card for a lady. These tickets will be issued shortly. In addition, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each, if purchased before the day of the Conversazione. On that day the price will be raised to 7s. 6d.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary at the offices of the Society, John-street, Adelphi, W.C. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman, and must be signed by the member applying for it.

Tickets will only be supplied to non-members of the Society on presentation of a letter of introduction from a member.

The programme of the arrangements will be announced in a future number of the *Journal.*

PROCEEDINGS OF THE SOCIETY.

TWENTY-FIRST ORDINARY MEETING.

Wednesday, May 26, 1909; PROFESSOR SILVANUS P. THOMPSON, D.Sc., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Adams, Arthur, 17, Blenheim-road, Bedford-park, W.

Black, David, 128, Upton-lane, Forest-gate, E.

Huntington, Archer Milton, Audubon-park, West 156th-street, New York City, U.S.A.

Mitchell, Francis Henry O'Connor, B.A., Government School of Engineering, Insein, near Rangoon, Burma.

Nevin, Miss Blanche, Churchtown, Lancaster County, Pennsylvania, U.S.A.

The following candidates were balloted for and duly elected members of the Society:—

Bishop, Rookwood Comport, J.P., Christchurch, New Zealand.

Chujo, S., 21, Sendagi-Hayashicho, Hongoku, Tokyo, Japan.

Clutton-Williams, J. P. C., Ph.D., F.S.S., care of Messrs. Balmer, Lawrie and Co., P.O. Box 4, Calcutta, India.

Harrison, C. W. Francis, Natal Government Offices, 26, Victoria-street, S.W.

Hay, Lieutenant John A. L., R.N., 13, Little Grosvenor-street, W.

Penn-Simkins, George, care of Messrs. Thomas Cook and Son, P.O. Box 26, Calcutta, India.

Smith, Thomas Fison, 4, McLean's-buildings, New-street Square, E.C.

The CHAIRMAN, in introducing Mr. Eyde, said it might be well for him to preface the paper by a word or two. The process for the manufacture, artificially, of nitrates, had been known for three or four years, in the commercial stage. In all great industrial advances one naturally went back to a beginning, and he supposed one would not be far wrong in saying that in every such advance there were four or five stages. There was first the initial stage of the discovery, when it seemed comparatively unimportant, an addition to the useless knowledge of the world. Such a discovery was made by Cavendish, 125 years ago, when

he found that the nitrogen of the air was oxidised by the electric spark. And then there came—often much later—the realisation that apparently useless knowledge was of some importance, and might have practical application. And that happened about 1898, when Sir William Crookes dared to point out—prophet-like—that the time might come when the world's supply of food would be imperilled by the increase of population and the increase of the wheat-consuming peoples of the world, and when, therefore, agriculture would fail to keep pace with the food needs of mankind, unless new sources of artificial manures could be discovered to replace the limited supply of natural fertilizing agents. For it was only too well known that the supply of nitrate of soda from Chili was limited, and would come to an end before very long. The third stage was that of technical realisation. The inventor came along and discovered the way of putting the piece of useless knowledge into useful shape. And here came in a gentleman whose name was well-known in science—he regretted he was not present to-day—Professor Birkeland, whose researches began with the Aurora Borealis, and turned on the question of the effect of producing electrical discharges in the presence of a magnetic field. He then observed a remarkable and singular electric flame, which at once appeared to him to lend itself to new developments. Calling to his aid Herr Eyde, an engineer of great experience, they together perfected the particular electric arc furnaces in which air could be burned electrically. The nitrogen of the atmosphere, inert in itself, combined with a portion of the oxygen, and as a result gases were produced which could be absorbed and turned into nitric acid or nitrate of lime, a material of which more would be heard from the author. Then there came the stage of commercialization. The invention having been made, it was put into operation on a sufficiently large scale. And in the exploitation of the invention our friends in Norway showed themselves amply equal to the occasion. He (Professor Thompson) had the opportunity, nearly three years ago, of visiting the first little factory at Notodden, which had since developed into a very large place—the author would say how many thousands of horse-power there were at present utilised for the production of the new nitrate of lime; and with that great commercial development the new industry had been begun. Lastly, there was the stage for the utilisation of the products of the new industry, where the question turned entirely on its agricultural value, and not only agricultural, because the new products were utilised for other industries, such as the manufacture of explosives, and of coal-tar products. So that in many ways it was a new discovery, which had made itself felt, and was still making itself felt, in different directions, which appealed to a very large section of the civilised world.

The paper read was—

THE MANUFACTURE OF NITRATES FROM THE ATMOSPHERE BY THE ELECTRIC ARC—BIRKELAND-EYDE PROCESS.

By Herr Sam Eyde,
Of Christiania, Norway.

More than a hundred years ago, Priestley and Cavendish observed that the oxidation of atmospheric nitrogen took place on heating in an electric flame, and men like Sir William Crookes and Lord Rayleigh have, with others in recent years, given valuable contributions to the subject. With respect to later experiments before those of Birkeland and Eyde, which are of a more practical nature, the work which Lovejoy and Bradley have done should be mentioned as very important. Time will not admit of entering into the details of the various systems. In shortly describing the difference between previous methods and that of Birkeland-Eyde, it must suffice to say that the latter have applied large quantities of electric energy in the electric arc, and have found out the best method of doing this, while it was previously believed that it was small quantities of energy that gave relatively the best results. It is on that assumption that the apparatus employed by them was constructed. Thus the invention of Birkeland-Eyde completely revolutionised the theory of the process of atmospheric combustion.

By bringing great quantities of energy into the electric arc, and finding the most suitable electric conditions and most serviceable types of furnace, Birkeland-Eyde created the synthetical nitrate industry.

I venture here to express my belief that, however many systems may be discovered in the future, and whatever improvements any of these systems may effect, with regard either to the product or the method of production, they will all, in a greater or lesser degree require to employ large quantities of energy in the electric arc.

In order to explain the Birkeland-Eyde method, it is necessary first to describe the flames, consisting of arcs of light, which are used in the electric furnaces.

The formation of the flame occurs through an arc of the electric flame being formed between the points of the electrodes, which are close to each other. By this an easily movable and flexible current is established which, with the arrangements made, will be found in a highly magnetised field. The electric arc that has been formed, moves on

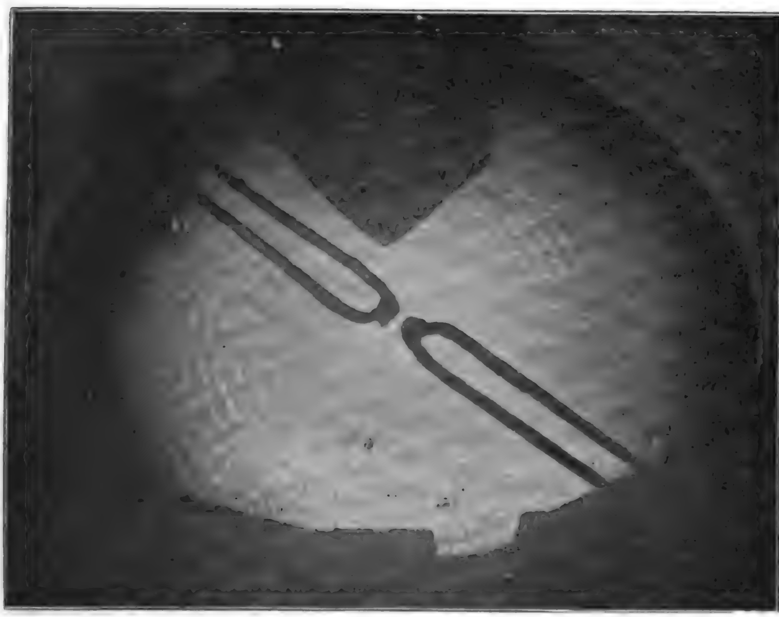
account of this magnetic field with great velocity perpendicularly to the lines of force, and the electric arc's foot draws back from the points of the electrodes. When the length of the electric arc increases, the electric resistance becomes greater and the tension increases, until it becomes so great that a new electric arc starts from the points of the electrodes.

To regulate the current, an inductive resistance is used in series with the flame. With alternating current, all these arcs are formed in opposite directions and appear to the eye to be circular discs. It appears that we have discovered in this flame a powerful technical means for the oxidation of the nitrogen of the air. The flame in our furnaces burns with a steadiness that is really astonishing.

On electrodes of 1·5 cm. thick copper tubing, through which water passes for cooling them, one can take up over 1,500 horse-power, with a flame 1·8 m. in diameter. The chamber in which the flame burns is circular, of only a few centimetres width, and about 2 metres diameter. After the oxide of nitrogen is formed in the furnace, it is converted in the oxidation tank into dioxide of nitrogen, and in the absorption towers into nitric acid.

From furnaces no larger than could be held in the hand, and which took an energy of some few horse-powers, we have attained to types which can, as mentioned, take an energy of more than 1,500 horse-power, and from absorption apparatus of glass globes of a few litres capacity, to absorption towers of granite with a capacity of 600 cubic metres each. We have in the course of this period of developing our method had four experimental stations. The first attempts were made at Frognerkilens factory in 1903. As we could not obtain more than 20 kilowatt of electric energy there, the experimental station was removed in October, 1903, to a building of our own on Ankerlökken, with power from the Christiania municipal electric power station, and, to obtain still more power, to Vasmoen, near Arendal, and later to Notodden.

Fig. 1.



Birkeland-Eyde Electric Furnace.

The Furnace House.

The building in which the furnaces are placed has a floor surface of about 2,000 square metres. It is entirely constructed of masonry and iron. In the basement are tubes for admitting the air and others for carrying off the gas. The power from our station at Svælgfos is brought in by 18 copper wires, each 12 millimetres in thickness. When these

have been brought into the furnace house, they pass through oil-cooled current converters. In order to be able to supply each furnace with the amount of power desired, each is furnished with an induction coil, by means of which the power is regulated as required. The induction coil serves, moreover, to make the flame in the furnace steady and even while working. Of the 36 furnaces installed, 32 receive their power from Svælgfos and 4 from Tinfos power station.

The flame chamber of the furnace is formed of fire-clay brick, through the walls of which the air is conveyed to the flame. The nitrous gases formed in the flame escape through a channel made along the casing of the furnace, which, like the flame chamber, is furnished with fireproof lining.

With this furnace we have achieved such steady working, that it burns for weeks without any regulation worth mentioning. It may further be stated, that the maintenance of the furnace and its repair are simple to a degree, as the most exposed portions, the electrodes, only require to be changed every third or fourth week, and the fireproof masonry every fourth to sixth month.

The temperature in our flames exceeds 3,000 or perhaps 3,500 degrees Centigrade. The temperature of the escaping gases may vary between 800 and 1,000 degrees during ordinary working. The furnaces are made of cast steel and iron, the middle of the furnace being built out to a circular flame chamber. The electrodes are led radially into this flame chamber. By aid of centrifugal fans, the air is brought into each furnace through tubes from the basement.

When the air in the flame chamber has been treated by the electric flames, the nitrous gases formed pass out through a channel built along the casing of the furnace and thence out through the lower part of the furnace to two fireproof-lined gas-collecting pipes, about 2 metres in diameter, which convey the gas through the basement out to the steam boiler house. In the boiler house, the gas passes through four steam boilers, in which the temperature, which was, as mentioned, 1,000 degrees Centigrade, is reduced. The heat given off by the gas is used for concentrating the products, and in the winter time for warming the factory buildings.

FIG. 2.

VIEW OF NOTODDEN FACTORY.

The steam produced in the boilers is utilised in the further treatment of the products. In the boiler house there are also two large and two small air compressors, which supply compressed air for pumping acids and lye in the factory's various chemical departments.

The gases pass on from the steam boilers through an iron pipe into the cooling house, with the object of completing the cooling commenced in the steam boilers. This cooling is necessary in order to obtain a suitable absorption. Each cooler consists of a great number of aluminium tubes, over which cold water runs, while the hot gases pass through them. The temperature of the gas is considerably reduced. From the cooling chambers the gases go on to the oxidation tanks.

These oxidation tanks are vertical iron cylinders, lined with acid proof stone. The object is to give the cooled gases a sufficient period of repose, in which the oxidation of the oxide of nitrogen may have time to take place. The necessary amount of oxygen is present in ample quantity in the air which accompanies the gases from the furnaces. From the oxidation tanks, the gases are led into the absorption towers. All the towers are filled with broken quartz, which is neither affected by nitrous gases, nor by nitric acid. To assist the passage of the gases on their way from the furnaces, there are centrifugal fans, constructed of aluminium, on each row of towers.

The gases enter at the base of the first tower, go up through the quartz packing and thence by a large earthenware pipe enter the top of another tower through which they pass downwards through the quartz to the bottom of the third tower, and so on, until the air, relieved of all nitrous gases, leaves the last tower. Water trickles through the granite towers and this is gradually converted into a weak nitric acid, while the liquid used in the wooden towers is a solution of soda. The absorbing liquid enters the top of the tower and is distributed in jets by a series of earthenware pipes, so that the permeating gases come in immediate contact with the absorbing liquid. In the granite towers nitric acid is thus formed, and in the wooden towers a solution of nitrate of soda.

The liquid emerges in a constant, even stream from the bottom of the towers, that from the granite towers running into a granite cistern. Hence it flows into the "montejus" which serve to pump up the acid, which has to pass repeatedly through the tower before it has become strong enough for the purpose for which it is intended. The "montejus" are of stoneware strengthened with iron shields, are worked by compressed air, and send the acid up into large stoneware jars. From these jars the acid again runs through the towers as described. The "montejus" work automatically. The wooden towers are percolated, as already mentioned, by a solution of soda, otherwise the whole process is practically similar to that in the granite towers. The solution of soda, owing to its far greater power of absorption, effects the separation of the last remains of nitrogenous gases from the accompanying air. Of the entire quantity of nitrous gases passed through the absorption system, about 97 per cent. is absorbed. The finished nitric acid coming from the towers, which has a strength of about 30 per cent. by volume, is collected in granite cisterns, from which it is drawn to what is called the "dissolution works." These consist of granite vats filled with limestone, over which the acid is poured. This drives off, with violent effervescence, the carbonic acid contained in the limestone, while the nitric acid takes its place and forms a watery solution of nitrate of lime or calcium nitrate. This solution of nitrate of lime is now pumped into vacuum evaporating apparatus. The object of boiling in vacuum is the well-known fact that great saving is thereby effected in the heat required.

The steam required for the evaporisation is obtained from the steam boilers, heated, as before mentioned, by furnace gases. The concentration of the nitrate solution in the evaporising plant is continued until the specific weight of the liquid at a given temperature shows a content of 13 per cent. of nitrogen. This solution is then sufficiently evaporated, and can be pumped up into the solidification chambers. These are fitted with shallow iron pans, under which cold air is pumped to accelerate cooling. After some time, the nitrate stiffens into a brittle, crystalline mass, hard as stone. This is broken up into lumps, and is taken into the crushing machines. These consist of ball crushing mills, which reduce the mass to a granular state. The coarse powder so produced is raised by elevator to a vat, from the bottom of which it is tapped into casks holding 100 kilos net weight.

The barrels are made at our own coopers' shop and are lined with paper to guard against damp. The colour of the product depends on the limestone used in the manufacture. The nitrate of lime is used in various chemical works as well as for manure, the only difference being that, for the former purpose, the product is not ground fine, but is run direct in the liquid state into thin iron drums, in which it stiffens into a solid mass.

The Manufacture of Nitrite.—Nitrite of Soda.

It now remains only to mention the further treatment of the nitrite formed in the alkaline towers. When this is pumped away from the towers, it contains, besides nitrite and water, also some nitrate of soda, and bi-carbonate.

The further process is designed to separate the pure nitrite from the other substances. This is accomplished by first boiling away some of the water, which is done, as in the

case of the nitrate solution, by steam from the steam boilers, heated by the furnace gases. The nitrite solution, concentrated to a suitable boiling state, is run into crystallisation pans, in which the crystallisation of the nitrite takes place. The crystals are separated by centrifugal means and are conveyed by a screw transporter to a drying apparatus, where they are subjected to a current of hot air. The finished product is then run into casks containing 300 kilos each. These are likewise made in our own shops. This nitrite of soda is used as the raw material in the manufacture of certain kinds of aniline colours. The manufacture of nitrite is carried on in a special building.

In the entire process of manufacture, both of nitrite and nitrate, no coal is used; all the machinery is worked by electric power, and for heating and evaporating the nitrate and nitrite solutions, the only steam employed is that obtained by the hot gases passing through a system of steam boilers.

We are, moreover, in our industry, not confined to the two products hitherto mentioned, nitrate of lime and nitrite of soda, we have possibilities for the development of a whole series of new industries, of which I will specially name the production of nitric acid, nitrate of ammonia, nitrate of potassium and others.

We have succeeded, in conjunction with the Nobel (nitro-glycerine, &c.) Syndicate in concentrating our weak acids, by means of gases from our furnaces, to acids of a high percentage which can be transported.

Agriculture.—Trials with Nitrate of Lime.

In recent years a number of well-known men and institutes connected with agriculture have undertaken numerous experiments for the purpose of testing the effect of the nitrate of lime under various climatic and other conditions and on various kinds of soil. These trials have been made in Norway, Sweden, France, Germany, Austria-Hungary, Italy, and also in the United Kingdom.

All the experiments have fully confirmed the expectation which was held forth by men of science when this new manure first appeared, viz., that one pound of nitrogen in the form of nitrate of lime has the same effect, both in quality and quantity, as a similar amount of nitrogen in the shape of nitrate of soda, or, in other words, that nitrate of lime is equal to nitrate of soda as a manure.

At times, variations may be observed one way or another, in one case in favour of the nitrate of soda, in another in favour of nitrate of lime. But especially in soils deficient in lime, the nitrate of lime has proved superior.

A number of agricultural chemists have conducted pot-experiments to compare nitrate of lime with nitrate of soda. I may name amongst others:—Professor Sebelin, the College of Agriculture, Aas, Norway; Dr. E. Solberg, head of the Agricultural Experiment Station, Trondhjem, Norway; Professor Söderbaum, Sweden; Professor Paul Wagner, Darmstadt, Germany; Professor Th. Schloesing, jun., Paris; and Mr. James Hendrick, chemist of the Highland Society of Scotland.

They all affirm that the nitrate of lime has proved to be fully equal to nitrate of soda as a manure, as long as the same quantities of nitrogen are employed. Professor Wagner adds, that the nitrate of lime is preferable on soils that are deficient in lime.

The field experiments are of still more practical importance, and a number of such have been made in various places in different countries. Especially extensive and exact field experiments have been made in the Scandinavian countries.

Norway.—Professor Bastian R. Larsen, conductor of experiments at the Norwegian College of Agriculture, has, from 1904 to 1908, carried out a series of the most careful experiments to compare nitrate of soda with nitrate of lime.

Several parallel trials have been made each year, some on the college grounds, some on land in various parts of the country.

Putting the results for ordinary manuring with nitrate of soda at 100, the results for similar manuring with nitrate of lime have been:—

Potato crop 1904	146·3
,, ,, 1905	100·9
,, ,, 1906	97·1
,, ,, 1907	109·3
,, ,, 1908	100·0
Green fodder on marsh land 1906	106·1
Top dressing on meadow, 1908	100·3

The professor concludes with the words:—"The experiments referred to appear, on the whole, to demonstrate that the nitrogen in nitrate of lime is equally valuable as the nitrogen in nitrate of soda."

Denmark.—In Denmark a series of experiments has likewise been carried on for the purpose of comparing nitrate of soda with nitrate of lime. The Sealand Farming Asso-

ciations have carried out 37 different trials on a number of farms. Putting the results for ordinary manuring with nitrate of soda at 100, the results with nitrate of lime are:—

	Grain.		Straw.
Experiments with—			
Rye (1907)	100·5	....	101·0
Oats (1907)..........	103·3	....	100·5
Barley (1907)	99·9	....	98·4
„ (1908)	99·7	....	104·1
			Roots.
Beetroot (1907)	—	....	97·0
„ (1908)	—	....	98·8
Sugar-beets (1907) ..	—	....	101·1
„ (1908)....	—	....	96·6

Nitrate of lime has thus in some instances been a little below nitrate of soda, in others a little above.

Sweden.—The Director, Herr P. Bolin, gives the following account of local farm trials (practical cultivation trials) made by the Hushallnings Association in Sweden.

Putting (as before) the effect with nitrate of soda at 100, the results with nitrate of lime were:—

	Grain.		Straw.
Experiments with oats in 1904 ..	104·5	..	118·0
„ „ „ 1905 ..	137·5	..	100·0
„ „ „ 1906 ..	105·0	..	93·4
„ „ hay, 1906 ..	100·9		

In these experiments nitrate of lime proved considerably superior to nitrate of soda.

The director states respecting a number of experiments with roots in 1906:—"Apart from some irregular instances the experiments made with roots appear to confirm the observations which have previously been made by ourselves and others."

The United Kingdom.—The average results of three trials of nitrate of lime with oats made by Mr. James Hendrick, chemist of the Highland and Agricultural Society of Scotland, has been:—

	Yield per acre. Grain.		Straw.		
	lbs.		cwt.	qr.	lbs.
1. No manure	2,348	..	33	0	21
2. Phosphate and potash only	2,532	..	37	1	6
3. Same as 2 with nitrate of soda	2,774	..	41	3	1
4. Same as 2 with sulphate of amm.	2,774	..	41	3	24
5. Same as 2 with nitrate of lime	3,121	..	43	1	13

In these experiments nitrate of lime proved considerably superior to nitrate of soda.

Experiments with oats at the West of Scotland Agricultural College by Professor R. Patrick Wright.

Average of Two Trials.

	Yield per acre.				Ratio.	
	Grain.	Straw.			Grain.	Straw.
	lbs.	T.	cwt.	qr.		
Experiment of 1907.						
Nitrate of soda..	1890	1	12	3	100	100
Nitrate of lime..	2040	1	10	1	108	93
Experiment of 1908.						
Nitrate of soda..	2777	2	1	3	100	100
Nitrate of lime..	3121	2	3	1	117	107

In both the instances here quoted, nitrate of lime has thus shown itself to be superior to the nitrate of soda as a manure for oats, when the same quantity of nitrogen is employed, especially when the chief object is the weight of grain.

Experiments on roots at University College, Reading, by Professor John Percival:—

	Yield.
1. Nitrate of lime, $1\frac{1}{2}$ cwt. per acre ..	37 tons.
2. Nitrate of soda „ „ ..	36 „
3. Sulphate of ammonia „ ..	32·5 „
4. No manure	27·75 „

It should here be observed that the largest crops have been obtained with the use of nitrate of lime, even when the same gross quantities have been employed, notwithstanding that the nitrate of lime only contains 13 per cent. of nitrogen against 15 per cent. in nitrate of soda and 20 per cent. in sulphate of ammonia.

Experiments Made by Professor B. W. Bull, of the Essex Education Committee.

Mangold Experiments, 1908.

	Tons.	Cwt.
1. Dung, Superphosphate and Nitrate of Lime	29	12·8
2. Dung, Superphosphate and Nitrate of Soda	28	3·6
3. Dung, Superphosphate and Sulphate of Ammonia	26	7

A Trial of Slag, as a Spring Application.

	Tons.	Cwt.
1. Dung, Superphosphate and Nitrate of Lime	22	15·7
2. Dung, Superphosphate and Nitrate of Soda	21	18·7
3. Dung, Superphosphate and Sulphate of Ammonia	19	2·1

Svælgfos Power Station.

Svælgfos power station is about four and a half kilometres, barely three English miles, from Notodden factories, on the Tinn river,

which, by the regulation of the lakes Tinnsjoen and Mosvand, has been brought up to a constant supply of seventy-five cubic metres of water per second.

The power station consists, in its main features, of a weir or dam, by which the water level has been raised seventeen metres (about fifty-six feet).

A tunnel leads the water to the basin, whence it passes through four channels through the rock and lined with iron to the four turbines.

The effective height of the fall is forty-six and a-half metres—nearly one hundred and forty English feet.

There are four turbines installed, each of from ten thousand to eleven thousand seven hundred and fifty horse-power, thus, under normal circumstances, yielding forty to forty-five thousand turbine H.P.

The turbines are fitted with two wheels, to which the generators are coupled. The number of revolutions is two hundred and fifty per minute. They are constructed by the firm of Voith in Heidenheim.

The generators were built by the Allmänna Svenska Electriska Aktiebolag, Vesteras, are three-phased current machines, with fifty periods per second, six hundred ampères per phase, and a tension of ten thousand volts, delivered directly upon the line.

The power is conveyed to Notodden by three transmitting cables, each of six wires, and a fourth cable will shortly be added in order to utilise the power more completely.

The power station is erected in the bed of the river itself close in under the almost perpendicular western bank, and all the materials had to be lifted by cranes, fifty metres up or down. The heavy portions of the machinery were carried over to the power station by the aid of a very powerful aerial ropeway, stretched from the road on the east side of the river to the edge of the precipice.

This power station is of considerable interest, not only as being the largest water-power station in Europe, but on account of the plant there installed being doubtless the largest in the world at the present moment.

DISCUSSION.

The CHAIRMAN (Professor Silvanus P. Thompson) said that the account given by Mr. Eyde, who had taken so large a part in the development of the furnace and the factory, as well as the engineering works, was of great interest. The paper presented many aspects from which discussion might arise, and to an English audience perhaps the most interesting question was that of the agricultural application of the products of the new industry. He asked His Excellency the Norwegian Minister if he wished to say anything.

Mr. JOHANNES IRGENS (the Norwegian Minister) said he was not prepared to enter into any discussion of the subject, but he would like to say that the new industry just described was considered in his country to be of the greatest national importance. It gave employment to hundreds of workmen, in a locality where formerly there were only wild scenes of Nature, and though these were very picturesque, his countrymen preferred the present situation. In conclusion, he thanked the Royal Society of Arts and the Chairman of the occasion for their very kind welcome to his distinguished countryman.

Mr. A. D. HALL (Rothamsted Experimental Station) said that he welcomed the new nitrogenous manures, and he trusted that the proprietors of the various kinds would so cut one another's throats as to reduce the price of nitrogen to the farmer. Experiments had been made at Rothamsted with nitrate of lime, and they gave practically the same results as did nitrate of soda; and it was recognised as a thoroughly valuable fertilizer. On occasion it might prove to be considerably more valuable on certain soils than nitrate of soda, because in some work recently carried out it was found that one drawback to the use of nitrate of soda—on a clay soil nitrate of soda resulted in an unkind texture of the soil—was the preferential selection on the part of the plant for the nitric acid, leaving the base to combine with the carbonic acid secreted by the plant. The part left behind had an extraordinary effect in destroying the texture of the soil. Under the same conditions nitrate of lime would leave behind a very useful carbonate of lime, so that the deflocculent effect of nitrate of soda would be avoided in the new fertiliser. Speaking from his experience with the samples of nitrate of lime which he had seen, he would say that the only difficulty which they wanted to avoid, from the farmer's point of view, was in its mechanical condition. To use such a concentrated fertiliser was rather too costly, and its deliquescence rendered it necessary that it should be handled quickly after the casks had been unpacked. But no doubt these difficulties would be remedied, and then the farmer would have at his disposal another fertiliser of an extremely valuable class.

Mr. MARTIN ROBERTS asked if the author would give some idea of the cost of production; first, as to the current consumed; and secondly, the cost of the finished product.

Dr. RUDOLPH MESSEL said that in view of the remarks of Professor Hall about the deliquescence of the nitrate of lime and the condition in which the pro-

duct was issued, he wished to ask why the basic nitrate of lime was not used instead, as he recommended some years ago. He had no commercial interest whatever in the matter, but he had suggested that the nitrate of lime should be made in the form of a powder, or cast into blocks, in which form it could be sent out, even without the necessity of using casks. The saving in the cost of package alone would be considerable.

Mr. PORTHEIM asked whether for large cargoes, or for carrying any distance, the acid salt did not get too sloppy; and whether it was not a fact that the serious difficulty, in long transit and for sea voyages, unless it was carefully packed in separate casks, was that the material as a whole would rapidly absorb moisture from the air and arrive in a deliquescent condition. That was a point which he regarded as of great importance.

Mr. J. ROBINSON said he would like to hear what was the cost of the power used, because he thought that by utilising waste heat and gases in Great Britain they would be able to produce power at cheap rates, and comparable with those in Norway.

The CHAIRMAN said he was one of the few people who had had the opportunity of seeing something of the industry in its native place. That was nearly three years ago, when the industry was only in its beginning, and the factory at Notodden had only 2,000 horse-power available against the 40,000 at present used; and they had only three furnaces going, against 32, and before the development of the particular waterfall which was so well shown by the pictures. It was also before the barrage and channel had been made—a notable piece of engineering. Not the least interesting aspect was that which concerned the electrical engineer, namely, the generating station, and the very large power units contained therein. He had seen the Boïlefos, at Arendal, and had also visited one which the author had not mentioned, but in which he was interested, the Rujkan, in Telemarken, where there was available at least 220,000 horse-power. Already preparations had been made for regulating the flow by dams still higher up in the country, and projects were maturing for utilising that enormous power in two stages—1,500 feet was too high, on account of the great pressure generated. And when that was accomplished, there would be available an enormous source of power. In reference to the question which had been asked as to whether we, in England, were likely to be able to compete with that by the utilisation of waste furnace gases, he almost wished we might, but Nature had not blessed this country with such enormous waterfall powers. But though furnace gases were at present a drug on the market, he thought that by the time the necessary plant had been erected to utilise them the financial situation would be far from an easy one. He had been struck with the careful organisation in the factory which led to such economies in labour. Even in the first small factory, the amount of labour for supervision was very small, but it was proportionately very much smaller in the present large factory. But what struck him most of all was the method in which the whole finances of the undertaking were managed. There was no hawking about of a concession, no flaming prospectus to attract the greenhorn, no great names to show what a magnificent board of directors the venture possessed. The matter was arranged in a way which he thought they should all admire. They in this country had suffered from enterprises, themselves reasonable and scientifically sound, and commercially good if properly worked, being wrecked by being made the subject of commercial speculation before they had reached the paying stage. The electrical industry of this country was to-day under a very considerable cloud, a great part of which was due to the insane manner in which capital had been raised for all sorts of schemes which ought never to have been undertaken at all, or in a more quiet and reasonable way, without being over-capitalised. Their friends in Norway satisfied substantial bankers, chiefly of that country and of Sweden, that an industry could be created, and they called in privately the best men they could get from Germany, France, and Switzerland to advise them as to the possibilities, and test what had been already obtained on a small scale with 2,500 horse-power. And then, without asking for a penny from the subscribing public, the industry grew. It was not only a scientific process but science entered into its finance. He wished we in England could have schemes handled in the same way, and that we might be delivered from the unscrupulous promoter, who had played such a sad part.

Mr. L. GASTER asked whether it was true that there were difficulties in outsiders getting concessions, on account of the restrictions imposed by the Government, and whether the foreign capitalist could be interested in the development of water power without having to go to Sweden for it.

Herr EYDE, in reply, reminded the meeting that he was not a part of the Government of Norway, but he had not previously heard that foreigners were so anxious to bring their capital to Norway. He could be sure of getting the amount of money he required. As the Chairman had rightly said, if an undertaking was good and sound, the money for it would be forthcoming. He really could not undertake to give information as to the cost of production and such information could not fairly be demanded, but he hoped their shareholders would get a profit out of it. With regard to the hygroscopic nature of the material as sent out at the commencement, they had very much trouble in that way, but now they had learned how to manage better, and he thought most people who received the material were satisfied with the form in which it came. Experience in its use was naturally required if the best results were to be

obtained. But nothing came to perfection at once; there was a gradual improvement, and it was the desire of the makers that such should be the case with this product. With regard to erecting plant in England, he hoped there might come a time when that was possible, but the output of the furnace and the cost of upkeep of the furnace were items which entered into the practicability of the matter. His own view was that even if such cheap power could be procured, they in this centre of trade and commerce would not utilise it for such things as nitrate manufacture, but on much larger schemes.

On the proposition of the CHAIRMAN, the author was heartily thanked for his paper.

THE TURKISH MOHAIR INDUSTRY.

It has been said that the goat, more than any other factor, has assisted the rural population of Asia Minor to destroy the magnificent forests which once extended from Smyrna through to Konia, the ancient capital of Karamania. Not only have the peasants and nomads destroyed the timber for the sake of firewood, but they destroyed it also in order that their goats might obtain suitable pasture. The goats in their turn prevented the new shoots ever after from replacing the trees which had been cut down. Goats, therefore, compose one of the chief sources of wealth of the country people in Turkey, and on account of the dry, saltish ingredients of the soil of the interior highlands, these are the animals which are best adapted to be reared on the least amount of money. They are also able to withstand the great extremes of heat and cold experienced in the plateaux of Asia Minor. In summer they wander with their owners over a vast extent of territory, and in winter they are sheltered in droves in rude sheds of skins and bark. The American Consul at Smyrna says that goats in Turkey usually belong to Turks, Kurds, and Yaruks, who, apart from the milk and flesh, prize the animal on account of its hair, which is becoming an increasing article of commerce from year to year. The price of a goat, unless it be a genuine Angora, is about the same as that of a sheep. At feasts and barbecues, which take place on all the religious and national holidays of Turks and Greeks, the goat takes a prominent part. The black goat species is shorn once a year, and the hair is used for making sacks for carrying olive oil and figs to the markets of Smyrna and Constantinople. The finest kind of leather is also made from the skin of the Broussa and Karchissar goat, and is sold principally to dealers in Vienna and Leipzig. Apart from the local use of goat hair and skin, large quantities are exported to foreign countries. The number of goats in Asia Minor is estimated at 3,000,000, and the value of the mohair annually produced is estimated at nearly £850,000. Small quantities only are shipped through Smyrna, Constantinople being the chief centre of the trade, which is practically monopolised by British merchants, who keep Bradford dealers and manufacturers well supplied with Turkish mohair. The Angora goat is famous the world over. Its native home is not the district of Angora alone, but it is to be found on the slopes and in the valleys of a great stretch of country which extends southwards through the heart of Anatolia. Its hair or wool is indispensable in the manufacture of manifold varieties of textiles. In Smyrna, even mohair is used in the production of certain grades of carpets. Two hundred years ago, the Angora goats of Armenia supplied the finest texture for making wigs which were commonly worn in those days by Europeans, and especially was this the custom at the various Courts. Anatolian mohair is used in making alpaca cloth for umbrellas, and it also enters largely into the make-up of certain cloaks and overcoats. Many yarns are made from the soft fibres. There are also some primitive sack-making industries in the interior of the country which cater for the tobacco trade, by supplying dealers with high-class sacks for exporting the seasoned leaves. It will thus be seen that mohair is adapted to many forms of usefulness. Once there was an important weaving industry in Angora. As far back as 1812, no less than 1,000 hand-looms furnished employment to 10,000 weavers. But for fifty years this industry has been dead. With the introduction of high-class machines, manipulated by skilful hands in the textile factories of Europe, the manufacturers of Angora at once gave way before this competition, and mohair and camel-hair is now exported by Armenian traders as a raw product. After Bradford, the factories of Roubaix, in France, consume the largest quantities of mohair. Of course, it must not be understood that European competition has completely crushed out the home weaving industry. Such is not the case. Even in Angora an extensive home industry still exists. Shawls and robes are still produced in large quantities, and are much prized on account of their durability and originality of design. All over Asia Minor, in fact, peasants and Yaruk women are to be seen sitting in their primitive houses, or goat skin tents, busily engaged in weaving some article for the nearest bazaar. Many attempts have been made to transplant the Angora goat to other countries. In 1890, it was sent to France and Spain, and about thirty years ago some high-class Angoras were smuggled out of the country at great expense and shipped to the Cape and Natal.

THE RUSSIAN OCCUPATION OF TABRIZ.

The advance of a Russian force under General Snarsky to Tabriz and the despatch of further reinforcements seems to betoken the long expected occupation, if not annexation, of the province of Azerbaijan, of which Tabriz is the chief town. The avowed objects of the Russian advance, as stated by Sir Edward Gray, "are to guard the Consulates, protect foreigners, and make sure of the opening of the

roads for food supplies," but in the highly disturbed condition of Persia it would not be surprising if these measures were spread over a lengthy period. Azerbaijan lies in the angle formed between Russian territory in the north, Turkish territory in the west, and the Caspian in the east, but it does not actually reach that sea, as a narrow strip of territory belonging to the Ghilan province runs up along the western shore of the Caspian past Astara, as far as the frontier river of Aras. The Consular report on the province for 1907-8 which has just been issued by the Foreign Office shows a considerable decline in trade as compared with the previous year, due in great measure to the troublous condition of the country. As in all other parts of Persia, the imports which amounted to more than a million sterling in 1907-8, exceeded the exports in value. Russia naturally stands first in the list of importing countries with a total of £476,488 worth of goods, the British Empire second with £343,489, and Austria-Hungary a very bad third. Our contributions are mainly cotton yarns, thread and tissues, woollen goods, tea and a little indigo, the last two items being of course from India. Nearly three-quarters of the Russian imports represent sugar. The chief exports from Persia are carpets and fruits. The best approach to Tabriz is by rail from Tiflis and Batum, but the railway goes no further than the frontier town of Julfa, the interval between that town and Tabriz being covered by a Russian road, one of the very few roads existing in Persia. It is along this road that General Snarsky and his reinforcements have made their advance.

HOME INDUSTRIES.

Unemployment Insurance.—The scheme of labour exchanges sketched last week by the President of the Board of Trade as the outline of the proposals the Government will submit to Parliament for the better regulation of labour, recalls the great work done by the London and India Docks Company, in 1891, by their policy of reform by "de-casualisation." Up to the time of the Dock strike, in 1889, the bulk of the work of the docks, on the north side of the river, was performed by purely casual labourers, taken on by the Dock Companies' foremen from a struggling crowd at the entry to each department. At least 10,000 men competed regularly for work that only required 3,000. The fact that credentials were not wanted, that anybody might compete for work at the docks, and stand an equal chance of getting it, attracted a perpetual stream of weaklings and failures from every other occupation. The work of many of these men was dear at 4d. an hour, and the system of dock employment was described as, in effect, "a gigantic system of out-door relief." But after the strike, in 1891, the Dock authorities determined upon a sounder system of selection. Men were ranked as permanent, "A," "B," "C," and casual. The permanent and "A" class were men on weekly wages, the men in the other classes were engaged and paid daily, but the "B" men had the preferential right to be employed next, after the regular staff, and before any "C" men were taken on, while the "C" men had a similar preference over the casuals. Within the "B" and "C" classes there was a similar grading of men, according to their place on the lists. The object aimed at was regular attendance for work, and a premium was put upon good behaviour since men were moved up and down the lists according to their merits. But although this reform did something, it did less than was expected, the weak point being that the company would not offer at all times a sufficient chance of work to secure the regular application of even all its "B" men. Owing to the great varieties of work a man might sometimes do better as a casual at one place than as a "B" man at his proper department. The Dock departments were too small to stand apart, and to maintain each its own reserve of labour, and so it was decided to make the whole of these northern docks into a single labour market, within which the required supplies of men should be directed from a central office to the different work places. This organisation has gradually developed until now 80 per cent. of the work done by the London and India Docks Company is performed by weekly labourers, and 20 per cent. by preference men and casuals. The preference lists are no longer important, the "C" list has disappeared, even "B" tickets are not much regarded, the permanent and "A" classes engross nearly the whole field of employment. In his "Unemployment" Mr. Beveridge states that whilst in 1891-92 the work performed by the weekly staff under the London and India Joint Committee was 45 per cent. of the whole, for the years 1902-4 it averaged 78 per cent. "The system," says Mr. Beveridge, "which obtains has the effect of shaking down to the tail end of the lowest list the men who are not industrious, steady, or honest; they only get work in emergencies, and the tendency is for them to drop off altogether."

Percentage of Unemployed.—The group of trades which the Government have selected to be the first subject of experiment in insurance against unemployment are "house-building and works of construction, engineering, machine and tool making, ship and boat building, vehicles, sawyers, and general labourers working at these trades." This group of industries comprise some 2,500,000 adult males, roughly speaking one-third of the total population of the United Kingdom engaged in purely industrial work. The unemployed percentage never fluctuates down to zero in any one trade. To take the three chief trades —named by Mr. Churchill—during the past twelve years the lowest figures recorded for the building trade were 0·8, in May, 1897; for engineering, 1·9, in January-February, 1897; for shipbuilding, 1·4, in July, 1897. To quote Mr. Beveridge once more, from 1881 to 1901, the persons returned as occupied in the census group corresponding to engineering, shipbuilding, and metal trades, increased in number

from 978,000 to 1,475,000, or more than 50 per cent., while money wages in engineering rose as from 88·36 to 100·29. The numbers in the building trades rose from 926,000 to 1,336,000, or 44 per cent, and the money wages from 85·5 to 100·0. The numbers in woodworking and furniture rose from 219,000 to 308,000, or 41 per cent., and those in the paper and printing trades from 196,000 to 334,000, or over 70 per cent. But during all this growth in the numbers employed—a growth in each group of twice or more than twice the rate for the general population—there was never in any of the groups a year without an appreciable number of skilled and organised workmen out of employment. For each group taken as a whole there appears to be much the same irreducible number below which the year's unemployed percentage never falls. In the best years all the groups alike tend to have about 2 per cent. unemployed. Even in a fluctuating trade like engineering a very large proportion of men escape unemployment altogether. In Tables compiled by the Amalgamated Society of Engineers (Manchester and Leeds districts), and giving the distribution of unemployment in the nine years 1887-95, it is shewn that the percentage unemployed for some time during the year was, taking the mean 29·7, rising as high as 39·8 in 1892, and falling to 18·0 in 1889. Irregularity in each year is concentrated on a minority, but the minority is always a fairly large one, and the Table referred to above shews the rather curious result that almost as large a proportion of workers (21·4 per cent.) became unemployed during the best years as during the worst (26·4 per cent.).

Marine Insurance. — The Marine Insurance (Gambling Policies) Bill now before the House of Commons is warmly opposed by underwriters. The object of the Bill is excellent. It is to put down the very objectionable practice which has become common during the last few years of placing lines upon ships on the chance of the vessel, or vessels, being lost, the assured, who has no *bona fide* interest, receiving the amount insured under a *p. p. i.* (policy proof of interest) policy. A considerable portion of more or less ordinary insurance has, for many years, been done *p. p. i.*, but, in the Bill, the two classes of operators, the legitimate, and the illegitimate "spotters," as they are called, are not sufficiently discriminated, and the lack of complete definitions in the wording of the Bill may, if allowed to remain, lead brokers and underwriters to avoid the ordinary and uncomplained of, as well as the extraordinary and properly denounced, *p. p. i.* transactions. As, however, the authorities have no wish to interfere with the unobjectionable operators, it may be assumed that the Bill will be so amended as to make the meaning clear; otherwise the re-insurance market may be seriously affected.

The Coal Trade and the Eight Hours Act.—The Eight Hours Act comes into operation in July, and it looks as if it will be the occasion of serious disputes in the coal trade. The object of this Act is to shorten the hours of labour, its effect must be to lessen wages if the view of employers prevails, and to increase the percentage of administrative charges if it does not. In Wales, masters and men are in sharp conflict, and in Scotland the employers have given notice of an intended reduction in wages of 12½ per cent. on the 1881 basis, which is equal to sixpence per day, and would bring the day wage down to 6s. 6d., the minimum wage under the working agreement made some years ago, when the Conciliation Board was reconstituted. Under its constitution this Board can adjudicate on claims to advance and reduce wages between 5s. 6d. minimum and 8s. maximum, but it cannot decide either above or below these rates. The minimum rate has, however, been ignored by the Scottish Miners' Federation under the working agreement, they having resolved on their own part that the minimum shall not be 5s. 6d. but 6s. per day, and they say that the present demand of the coalmasters is in effect to break the minimum wage. But the masters have never consented to the alteration of the minimum from 5s. 6d., and in these circumstances it is not easy to see how it can have been brought about. Either party can retire altogether from the contract by giving a stipulated notice, but no such notice has been given by the federation, and the miners are still represented on the Conciliation Board, which meets again next week, the idea being to temporise on the chance of an improvement in trade, of which there is no present appearance. The men seem determined not to have the minimum wage reduced below 6s., and the Miners' Federation of Great Britain has passed a resolution to do all in their power to prevent the wages of the Scotch miners falling below the present rate of 6s. per day. They have also declared by resolution that they will decline to accept any reduction in wages demands by any colliery owners as a consequence of the coming into operation of the Eight Hours Act. This Act may curtail output, but the smaller output will have to meet the same administrative charges. The employers affirm that a large majority of the collieries in Scotland are already working at a loss, and that if they are to be kept open, a reduction in wages is indispensable. The men gain the shorter hours, but they refuse to pay the price. Here are all the elements of a determined industrial conflict.

CORRESPONDENCE.

BOOKS ON WATER-MARKS.

Permit me to add to the list of "Books on Watermarks," given in the *Journal* of January 29th a small, but interesting work on the subject which is, doubtless, of sufficient importance to be included. It is:—

1856 (2nd edition). Richard Herring. "Paper and Paper-making, Ancient and Modern," with introduction by the Rev. George Croly, LL.D. London: Longmans. [Contains 30 samples of paper, several with "light and shade" water-marks, produced by a method then recently developed by William Henry Smith.]

The date of the first edition, which was issued by subscription, is not clear from the second, but it appears to be 1855. ROBERT STICHT.

Queenstown, Tasmania,
April 8th, 1909.

QUESTIONS AND ANSWERS.

NOTICES TO CORRESPONDENTS.

Readers in search of information which cannot be obtained from the usual sources are invited to make their wants known in the *Journal*, in the hope that they may be assisted in their difficulties by their fellow members.

On all communications must be written the name and address of the sender, not necessarily for publication, but as a guarantee of good faith.

Each question or reply should be written on a separate sheet of paper, and should bear such signature of the writer, and such address as he wishes to appear.

Questions which can be answered from the usual books of reference, will not be printed.

QUESTIONS.

GLAZIER'S LEAD VICE.—Can any member give me any information concerning the introduction of the glazier's lead vice? The earliest examples I have come across are those in the museum at Bruges, which are dated 1622, but it is certain that the practice of drawing out the leads in a machine, instead of using the rough castings direct, as was done in the earliest times, was introduced much before this. I would like to find out if any specimens of earlier machines are extant or if there is any evidence as to the time of their introduction.—N. H.

AMPHIBIOUS CARRIAGE.—Where can I find particulars of a carriage which was designed, I believe, in the early part of last century for running on land and crossing rivers?—LONG ACRE.

ANSWERS.

GOURDS AS WILD DUCK DECOYS.—"W. M." will find a description of the method in which gourds are used as wild duck decoys in the "Hand-book to the Weapons of War and the Chase" exhibited at the Horniman Museum:—"The natives of Venezuela obtain wild duck by a very ingenious method, also practised in China. The birds occur in great numbers in certain lakes and arms of the sea, but they are shy and difficult of approach. Some time before beginning the attempt the Indians hollow out large gourds, which they set floating on the water so that they finally reach the part where the birds are. These are at first afraid of the gourds and avoid them, but after a time they are regarded as harmless and natural objects. The Indian then cuts apertures for the use of his eyes in a similar gourd and places it over his head. He is then able to get among the ducks and capture as many as he wishes by seizing them by the legs and jerking them under water, when they soon drown. Each duck as it is killed is attached to the man's girdle, and an experienced hand will get all he can carry without alarming the survivors."—FOREST HILL.

CACAO BEETLE.—A useful little pamphlet on the "Insect Pests of Cacao" has just been published by the Imperial Department of Agriculture for the West Indies, in which the following methods are recommended for dealing with the cacao beetle:—"When it is known that the grub is in the tree, it may be dug out or the tunnel probed with a stout wire. The presence of this grub may be detected by the chips and excrement thrown out at the mouth of the burrow. The bark over the infested area shows a dried and shrunken appearance, and by removing a portion of such bark the burrow may be found. Any wounds made in the tree in digging out the beetle grubs should be promptly tarred over, or treated with a mixture of rosin oil and tar, to prevent the entrance of fungi. It will probably be best to remove all dried bark, and thoroughly clean the wood, wherever these injured places are found. If the wood thus cleaned is properly tarred over or painted with rosin oil mixture, the bark will grow over the wound satisfactorily. The adult beetles are active by night, and may be found resting on the trunks and larger branches of the cacao tree in the early morning. At this time they may be collected, and if thrown into the water, to which a small amount of kerosene has been added, they will be quickly killed. In Surinam, it is the common practice to tie large pieces of bark of the silk cotton tree to the trunks of the cacao, to furnish a hiding place for the beetles. They may be collected from these places during the day. It would seem likely that strips of burlap (bagging) tied round the cacao trunks would, as in the case of silk cotton bark, furnish convenient places for collecting these beetles. In Grenada, the cacao beetle is trapped by leaving the branches which are cut from the trees on the ground for about three weeks. All wounds on the trees which might attract the egg-laying beetle are tarred carefully. The adult beetles will visit the dead branches on the ground and deposit their eggs. These branches are then collected and burned. It is necessary that the branches be thoroughly destroyed. If they are neglected or left too long, they become breeding places for increasing the numbers of the beetles."—GRENADA.

GENERAL NOTES.

THE MANCHESTER CANAL.—Manchester has been a port for ocean-going steamers for fifteen years, but it will surprise many to learn that in money value of imports and exports of merchandise in 1907 Manchester ranked fourth of all the ports of the United Kingdom. London and Liverpool were, of course, easily first with totals exceeding £300,000,000 sterling each. Hull came third with £70,000,000, and Manchester next with £47,000,000, for the first time slightly exceeding Glasgow. Yet in March last the exports of cotton goods from Manchester was only 11 per cent. of the aggregate from all British ports. Manchester, where most of the goods were packed, would seem to be the natural shipping port, and cargoes, case goods especially, arrive at their destinations abroad in better condition if shipped at Old Trafford after a minimum of handling than if embarked elsewhere. Between 1895 and 1907 there was an increase from £13,000,000 to £47,000,000 in the values of merchandise in and out of the port. There was a set-back last year due to the general depresssion of trade, and the loss of an exceptional coal traffic, but ultimate financial success may be confidently expected, and directly and indirectly the canal has benefited Lancashire very considerably. It has brought money into Manchester, reduced port charges at Liverpool, and the cost of inland transit; stimulated Liverpool and Birkenhead, and found employment for many hundreds of labourers. The canal is one of the great works of the world, and is the first instance of an inland town constructing a waterway 36 miles long and 28 feet deep from the dry to the sea, and fitting its docks with the most up-to-date equipment.

CO-PARTNERY.—Encouraged by the happy introduction of a co-partnery scheme into the shipbuilding yards Sir C. Furness has made a somewhat similar proposal in connection with the Wingate Colliery. Having with two others purchased this colliery Sir Christopher Furness proposes to work it in co-partnership with those who get out the coal. The colliery produces one of the best known gas, household, and steam coals in the north of England. It yields about 350,000 tons of coal per annum, and employs rather over 1,400 men and boys. The whole property, including 1,000 acres of freehold estate, with £7,000 invested in Consols, has been bought for £175,000. A company with £200,000 capital has been formed to take over the property, and Sir Christopher Furness and his two partners will hold three-fourths of the shares, the workmen holding the other quarter. Every employee, whatever his status, will become a member of the co-partnery by signifying assent to its principles and acquiescing in the regular deduction of 5 per cent. from his pay until the shares to be allotted to him, and which he must apply for, are fully paid. The labour co-partners will participate to the extent of their share holdings in such profits as may be paid in dividends by the company. The control of the company's affairs will be vested in the board of directors, and no one but the management will have authority to discharge or engage workmen. Alongside this administration, however, there will be a colliery council composed equally of representatives of the directors and of the employees, a body which will have power to investigate and brings efforts of conciliation and persuasion to bear upon controversy between employees and employers, or their representatives. Failing agreement, matters in dispute are to be referred to arbitration by a court of representatives of employers and employees presided over by the county court judge of the district, or his nominee, the chairman of such court to be regarded in the last resort as the final arbiter in all matters of dispute. The working of this experiment in co-operation will be watched with interest.

MEETINGS FOR THE ENSUING WEEK.

TUESDAY, JUNE 1...Royal Institution, Albemarle-street, W., 3 p.m. Dr. T. G. Hopkins, "Biological Chemistry." (Lecture I.)

WEDNESDAY, JUNE 2...Royal Archæological Institution, 20, Hanover-square, W., 4½ p.m. 1. Nina F. Layard, "A Note on Some Early Crucifixes, with Examples from Roydon, Ipswich, and Marlborough." 2. Mr. Francis W. Reader, "Exhibition of an Early Bone Crucifix lately Found at Clare Market." 3. Rev. H. Bedford Pim, "A Note on Fonts at Barnard Castle and Sedgefield, County Durham."

THURSDAY, JUNE 3...Aeronautical (at the HOUSE OF THE ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.), 4 p.m.

Chemical, Burlington-house, W., 8½ p.m. 1. The Wolcott Gibbs Memorial Lecture, by Professor Frank Wigglesworth Clarke, of Washington. 2. Mr. A. Scott, "The Molecular Weight of Tetraethylammonium bromide and the Atomic Weight of Carbon." 3. Mr. V. H. Veley, "The Rate of Formation of Azo-derivatives from Benzenoid Diamines." 4. Mr. A. H. Salway, "The Synthesis of Substances Allied to Cotarnine." 5. Messrs. J. C. Irvine and A. Hynd, "Monomethylfructose and its Derivatives. Constitution of Fructose diacetone." Mr. W. H. Mills and Miss A. M. Bain, "Optical by active δ-oximino-hexahydrobenzoic Acidand the Configuration of the Oximino-group. Preliminary Note."

Linnean, Burlington-house, W., 8 p.m. 1. Prof. J. A. Thomson, "The Alcyonaria of the *Sealark* Expedition." 2. Mr. H. A. S. Gibson, "The Cephalochorda of the *Sealark* Expedition." 3. Mr. R. W. Harold Row, "Report on the Porifera (collected by Mr. C. Crossland) in the Red Sea."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. E. Dalby, "A Modern Railway Problem: Steam *versus* Electricity." (Lecture I.)

FRIDAY, JUNE 4...Royal Institution, Albemarle-street, W., 9 p.m. Professor J. R. Fleming, "Researches in Radio-Telegraphy."

Geologists' Association, University College, W.C., 8 p.m. Mr. Leonard Johnston Wills, "The Fossiliferous Lower Keuper Rocks of Worcestershire."

SATURDAY, JUNE 5...Royal Institution, Albemarle-street, W., 3 p.m. Dr. E. F. Blackman, "The Vitality of Seeds and Plants: (1) a Vindication of the Vitality of Plants."

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FRIDAY, JUNE 11, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

CONVERSAZIONE.

The Society's Conversazione will be held, by permission of the Trustees of the British Museum, in the galleries of the Natural History Museum, South Kensington, on Tuesday evening, June 29th, from 9 p.m. to 12.

The Reception, by Sir William H. White, K.C B., F.R.S., Chairman, and the other Members of the Council, will be held in the Central Hall from 9 to 10 p.m.

A Selection of Music will be performed by the Band of H.M. Royal Engineers, in the Central Hall, commencing at 9 o'clock.

An Instrumental Concert by the "Red Band," under the direction of Mr. Thomas Batty, will be given in the Fish Gallery from 9.15 till 10.15 p.m., and from 10.30 till 11.30 p.m.

A Gramophone and Auxetophone Concert, under the direction of the Gramophone Company, will be given in the Shell Gallery at intervals from 9.15 p.m.

The following portions of the Museum will be open :—

The Central Hall, containing cases of specimens illustrating Mimicry; adaptation of colour to surrounding conditions; protective resemblance, &c.; also specimens illustrating the food of Fishes, and the life-history of the Eel (East of staircase).

The North Hall, containing the collection of Domesticated Animals.

The Bird Gallery, containing groups of British Birds and Nests; and in the Pavilion, at the West end, an exhibition of the Land and Fresh-water Vertebrate Animals of the British Isles.

The Fish Gallery, containing the Great Basking Shark, the grotesque deep-sea fishes (case 44), the Tunny (case 38), the Tarpon and Angler-fish (case 27), the Lemon-sole (case 30), &c.

The Shell Gallery, including a life-size model of a Giant Squid (Newfoundland), and of a giant Octopus (California).

The East and West Corridors on the First Floor, containing the Okapi, African Antelopes, and Giraffes.

Light Refreshments will be supplied at Buffets in the North and South Corridors on the First Floor of the Museum.

Visitors travelling by District Railway (or other underground railways in connection therewith) will be allowed free use of the Company's Subway, which leads from the South Kensington Station direct into the grounds of the Museum.

Each member is entitled to a card for himself (which will not be transferable) and a card for a lady. These tickets will be issued next week. No application for them is necessary. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by members, at the price of 5s. each, if purchased before the day of the Conversazione. On that date the price will be 7s. 6d.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary at the offices of the Society, John-street, Adelphi, W.C. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman, and must be signed by the member applying for it.

Tickets will only be supplied to non-members of the Society on presentation of a letter of introduction from a member.

It will greatly facilitate the arrangements if members requiring additional tickets will apply for them at as early a date as convenient.

The Council reserve the right of stopping the sale of tickets or of raising the price, if it is found necessary, in order to restrict the number of visitors within reasonable limits.

Further particulars as to the Musical and other arrangements will be given in the Programmes which will be distributed on the evening of the Conversazione.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

Tuesday afternoon, May 18th; The RIGHT HON. LORD HINDLIP in the chair.

The paper read was—

CANADA AS A FIELD FOR BRITISH INVESTMENT AND SETTLEMENT.

By J. OBED SMITH,
Assistant Superintendent of Emigration, Department of the Interior, Canada.

With no little diffidence do I contemplate the comprehensive title of my paper. I realise at once the honour and the great responsibility of undertaking to discuss a matter of such moment before a society many of whose members are acknowledged "masters of finance," and men of unequalled experience in commercial matters, to whom perhaps some of my opinions may seem somewhat immature. I purpose offering some observations and suggestions which may interest those to whom it is given to influence in reality the movement of capital.

I claim to have had some acquaintance with persons seeking a livelihood in Canada, and as the human being unquestionably forms the bed-rock basis of expanding commerce, I hope I may be pardoned if I digress at times from the path leading up to so wide and brave a title into by-ways which will enable me to exhibit for your consideration some opinions gathered from many years' experience in assisting the settlement and development of a great over-seas dominion of the British Empire.

The vastness of Canada's area is now generally known to every school child and his elders—thanks to the improving means of communication with the Old Land—and I seldom refer to it except to impress an optimistic Yankee with the fact that the biggest thing in America is not the United States. Although I freely admit that there is some cold storage in Canada's Northland that we would exchange for a strip in California, still extent of territory has something to do with my subject.

I desire to point out

1. That capital already invested in Canada is safe and profitable, has been placed with selective care, and based on the reasonable needs of her great economic development.
2. That the prime needs of the Dominion and the provinces must continue to open up opportunities of securing investment for more capital.
3. That the immigration of large numbers of new settlers, with small or large capital, is changing economic conditions there, and making investments more necessary, and, therefore, more secure.
4. That opportunities are daily opening for profitable investment.
5. That American capital is seeking control of Canadian industrials.
6. That there is more than a possibility of shipping Canadian grain, with profit, *viâ* Pacific ports to Great Britain, and
7. That the possibilities of increasing commerce on the Pacific Ocean will attract capital, and warrant serious consideration.

BRITISH INVESTMENTS.

It is true that a large amount of British capital in the aggregate is invested in Canada. A prominent Canadian financial authority estimated this two or three years ago at about four hundred millions sterling in known securities, and exclusive of considerable sums in investments of which the particulars are not published.

I do not value very much sentiment in business. Capital, like water, finds its way out when the right occasion offers, and information is furnished on sound business lines. The sentiment of Canada's preferential tariff in favour of the Motherland is, to my mind, lost in the advantage of increasing trade caused thereby. Wealth primarily lies in the land. Canada is digging as much wealth from that first source as she can. She is growing more wheat per acre than the United States is growing, she is filling up her vacant spaces, and the expanding figures of the crop returns prove the wisdom of concentrating on the development of the country's natural resources; but there comes a time in a nation's history, as in every commercial enterprise, when the working capital must be increased, or development be retarded. More capital, therefore, seems to me Canada's need to-day, and it appeals at once as a sound reason for seeking British investment. It is gratifying to note that while steamship lines trading with the States are passing dividends and using reserve funds on account of last year's business losses, the Canadian lines have not suffered from the same financial stress.

Mr. Byron E. Walker, the General Manager of the Canadian Bank of Commerce, recently said:—

"The marketing of the actual proceeds of the field, forest, and mine of itself requires that large additions should be made to railroad equipment, and that other building operations should be carried out. Canada in 1908 was doing more business than was justified by the money at our command at home, or that could be secured abroad by the sale of securities the country was creating."

And Mr. William Mackenzie, President of the Canadian Northern Railway, speaking lately in Washington, said:—

"We have got to develop this country, and we cannot do it fast enough. We are short of men and short of money compared with what we can find use for. Canada is even bigger than the Americans who come into it. If it were not they would not come. They get more than they bring."

Canada's story begins with the discovery of Nova Scotia and Newfoundland by a Norwegian, Leif Ericson, nearly 500 years before Columbus found the America appropriated as the special title of the United States. After being practically forgotten for centuries, the granting of a trading charter to the gentlemen traders in Hudson's Bay in 1670 made the first real connection of at least the great central parts of Canada with British capital. It was at the same time a master-stroke of political-commercial policy which largely determined the destiny of half a continent, and disclosed the value of that vast area to the Empire. How well the venture has paid the shareholders the present market quotations will sufficiently indicate. One of the chief posts in that enormous territory, which extended originally a considerable distance south of the international boundary, was Fort Garry, or what is now the marvellous city of Winnipeg, with 125,000 inhabitants.

The Hudson's Bay Company sent their sailing vessels at specified times during the year to Nelson or Churchill on Hudson's Bay (as near Liverpool as Montreal), the cargo was transferred to large, strong row boats, and, barring an occasional portage, was transported over a continuous waterway to what is now Winnipeg.

The engineer's first report of survey presented this session to the Canadian House of Commons refers to the possibility of improving the waterway for this purpose. The project may remain in the clouds for a generation, but it is not impossible or improbable that steamers will take cargo at the wharves in Winnipeg, and deliver the products of the prairies in unbroken bulk at the port of Liverpool.

With the isothermal lines running in a north-westerly direction and the altitude of the land steadily declining as one proceeds northwards, the climatic conditions and resources of the great second-storey (as it were) of Western Canada are to-day as popularly misunderstood as were the conditions of that portion opened up by the Canadian Pacific Railway, which formed in the early eighties the subject of most outrageous criticisms.

Those who think such a project too fanciful would not be alone in their honest opinions, for so great a critic as *Truth*, on September 1st, 1881, wrote the following about the Canadian Pacific Railway:—

"It will run, if it ever be finished, through a country frost-bound for seven or eight months of the year, and will connect with the Eastern part of the Dominion a province which embraces about as forbidding a country as any on the face of the earth. The New Yorkers are keen enough gamblers and reckless enough at times, and yet it is impossible to believe that they are such fools as to put their money into this mad project. I would as soon credit them with a willingness to subscribe hard cash in support of a scheme for the utilisation of icebergs, and Canadians must know it is never likely to yield a single red cent. of interest on the money sunk in it."

What is the value of that prophecy to-day with this railway's shares over 170, and a traffic which requires 45,418 freight cars, 1,819 passenger cars, and 1,412 locomotives for its business, and having at Winnipeg the largest railway yard in the world? I venture to predict that the resources of Northern Canada will furnish results as triumphant as in the case of the Canadian Pacific Railway. *Truth* also referred on that occasion to Winnipeg as follows:—

"The people who have gone there cannot stand the coldness of the winters, men and cattle are frozen to death in numbers that would rather astonish the intending settler if he knew, and those who are not killed outright are often maimed for life by frost bites. Its street nuisances kill the people with malaria or drive them mad with plagues of insects, and to keep themselves alive during the long winter they have to imitate the habits of the Esquimaux."

That was 27 years ago; yet, notwithstanding the prophecy, Winnipeg exists in fact, and to such purpose that the bank clearings for 1908 exceeded 614,000,000 dollars. There are 377 miles of sidewalks, 300 miles of paved and graded streets, and the new buildings erected

in Winnipeg during the past six years exceed 50,000,000 dollars in value.

Further prediction was made at that time by *Truth*. "This Dominion is, in short, a fraud all through, and is destined to bust up like any other fraud." This prophecy may now be regarded as of little consequence, and the *amende honorable* was made long ago, but I quote it for the reason that one cannot place too strict a limit on possibilities that may now seem far distant. Rather would I turn to the statement made by the late Hon. Alexander Mackenzie, one of the early Premiers of Canada, during the Confederation debates at Quebec in 1865, when he said:—

"If there is anything that I have always felt anxious about in this country it is to have the British Possessions put in such a position that we could safely repose without fear of danger from any quarter, under the banner which we believe covers the greatest amount of personal freedom and personal happiness that is to be found in the world. And when we look to the vast territory we have in the North-West, we know that the great rivers which flow through that territory flow through immense beds of coal, and that the whole country is rich in mineral deposits of all kinds—petroleum, copper, gold and iron, that the land is teeming with resources of wealth, calculated to build up an expansive and valuable commerce and support a powerful nation; that all this we can touch and seize upon the moment we are prepared to open up a way to reach them, and allow the settler to enter that vast Western country, where there is hardly a white man living to-day."

Canada occupies middle ground between the East and the West, and one cannot imagine the total of her development, as only the merest edge has been trimmed by the scissors of wise commercial men, and only the top surface of a very small proportion has been scratched by the plough.

The Canadian Northern Railway is opening up a little Empire each year, and the best evidence of the magnitude and necessity for the Grand Trunk Pacific Railway is ably set out in the following interview with Mr. Charles M. Hays, the president of that trans-continental highway:—

"Bear in mind, please, that railroads are not now built as the earlier trans-continental roads were built, up hill and down dale, on an unballasted roadbed of mud. What we require to-day, and what the travelling public means to have is a first-class roadbed with such low gradients and wide curvatures that our trains can be run at very high speed with perfect safety.

"We carry our road from Winnipeg over the Rockies to Prince Rupert with a maximum gradient of 21 feet to the mile going west, and 26 to the mile going east. The immense economy in hauling freights with gradients so remarkable, every railway man must recognise. We shall be able to put two thousand tons of freight into Prince Rupert from Winnipeg behind a single engine.

"Of the seven great railroad systems which to-day cross the Rockies and reach the Pacific, the Union Pacific with grades of 116 feet eastbound, and 105 feet westbound comes nearest to us. I will tabulate for you the grades of our six competitors, and the dynamics of an engine on each.

Railroad.	Max. Grade.	Tractive Resistance in Pounds per Ton.	Gross Capacity of Engine in Tons.
Grand Trunk Pacific	26	14	2,041
Great Northern	116	50	572
Northern Pacific	116	50	572
Union Pacific	116	50	572
Santa Fe	185	76	376
Canadian Pacific	237	96	298

"In other words, the same engine could haul up the maximum grade of the Grand Trunk Pacific nearly four times more freight in a train than either the Great Northern, or Union Pacific, over five times more than on the Santa Fe, and about seven times more than can be hauled up grade on the Canadian Pacific. These are remarkable figures, I am aware, and I accept the responsibility of putting them on record.

"We expect that our easy gradients, which are due not only or chiefly to our 'generous expenditures,' but to our possession of the Yellow Hea[d] Pass through the Rockies, will in a few years twi[st] around a great portion of the wheat export trade [of] the North-West, and with the opening of the Panam[a] Canal in 1914 send wheat to Europe (let alone Asi[a]) by way of the Pacific.

"At present the wheat crop is either hurried to th[e] ports on the great lakes, Duluth, Fort William, a[nd] Chicago, during the few weeks between threshin[g] and the closing of lake navigation in November, or is held up for six months in elevators at a conside[r]able cost, or again, if it is carried through to t[he] Eastern seaboard in winter, when the St. Lawren[ce] route is closed by ice, the long haul through hea[vy] snows makes the operation difficult, costly, and e[ven] disastrous both for the railway and to the farm[er]. West-bound from Saskatchewan and Alberta [to] Prince Rupert, the grades are easy; there is v[ery] little snow in winter, so that when the Panama Ca[nal] opens in six years I look to see Prince Rupert one [of] the very great grain ports of the world. I have m[ore] than once ventured the prediction that in my lifeti[me] we shall haul to the Pacific as much grain as we s[hall] haul to the Atlantic.

"The volume of traffic coming out of the [...] North-West, if we may judge from the way sett[lers] are already swarming in, will throw far more busi[ness] upon our existing lines than they can possibly han[dle]

The present cultivated area is but six million acres. As yet we have but scratched the surface. We shall require very shortly to do what the Canadian-Pacific is already doing in Manitoba, that is, double track our road to enable us to handle the traffic. Thus, the diversion of a large portion of the far western wheat trade will advantage every section of our road; it will enable us to give settlers much lower rates, because we shall even up our loads, sending full cars both east and west instead of only east. While we send cattle, grain and minerals west to Prince Rupert, we shall haul back east the coal and the lumber which the settlers on that three hundred million-acre farm need."

General Public Expenditure.

Dominion and Provincial Government bonds have been freely accepted in Great Britain, and public funds are needed to-day for the following purposes:—

(*a*). *Construction of Canals.*—The first canal was opened in 1781. Since then Canada has expended nearly one hundred million dollars, and will spend more in her attempt to load wheat into ocean-going vessels at points near her great central prairies, and carry the wheat unbroken through the Soo Canal, which carries three times the tonnage of the Suez Canal, and other waterways to the ports of England.

(*b*). *Construction of Railways.*—The first train on a Canadian railway ran in 1836, and to-day the Dominion railway mileage is greater than that of the British Isles.

(*c*). *Postal Service.*—The first post was a mail stage between Montreal and Quebec in 1721. Now the number of Post Offices in Canada is nearly 12,000.

(*d*). *Militia and Defence.*—The first military organisation consisted of 63 men in 1653. The present ambition of the Canadian Minister of Militia and Defence is to have a Canadian army of 100,000.

(*e*) *Public and Parliament Buildings.*—The first Parliament (that of Lower Canada) was opened in 1792. Now the system of government consists of a Federal Parliament, under the (Imperial) British North America Act, with specified jurisdiction in certain matters, and a local Legislature for each province, exercising control in other affairs.

(*f*). Encouragement of agriculture and immigration; protection of fisheries and general requirements.

Besides the general public enterprises I have mentioned the development of a new country needs fostering in many ways. The Federal and provincial Governments spend enormous sums of money annually along lines of betterment, for example, river protection works, to control and prevent disaster from floods, &c.; drainage of wet lands, making them fit for the plough; bridges and roads, to give settlers access to markets; public and normal schools for the training of children and their teachers; asylums for the insane, the deaf and dumb, the blind and the incurable; assistance to hospitals; steamship wharves and docks; breakwaters; lighthouses for the coast lines, and 600 miles of inland waterways; guaranty of titles to lands; surveys and the settlement on land; destruction of noxious animals, and noxious weeds, the farmers' foes; afforestation and protection of timber (Canada delivered six million trees to her farmers last year, free of charge); fish hatcheries for re-stocking depleted waters; preservation of game; telephones and telegraphs for farm and city; dairy schools and agricultural colleges; experimental farms, and encouragement of the stock and poultry industries; police protection in wide and sparsely settled areas; bounties on manufactures, &c. Various provinces specially needing more railways pledge their credit for large sums. For example, during the session of the Alberta Legislature just closed, that province undertook to guarantee the bonds of the Canadian Northern Railway, and the Grand Trunk Pacific Railway for branch lines equalling 1,681 miles, at a cost of 27,000,000 dollars, practically leaving no corner of the province unprovided for.

These are some of the characteristics of the gigantic and complex machinery which requires much money to make the wheels go round. Does it not seem that with a goodly land, progressive people, wise and safe Governments, the natural result is a continuation of expansion, which makes investment profitable and secure?

The Minister of Finance, referring to the development of the Domnion during the year ending 30th June, 1907, showed that in the previous decade Canada's imports increased from 120,000,000 dollars to 360,000,000 dollars; her exports from 140,000,000 dollars to 260,000,000 dollars, making a total trade increase in ten years from 260,000,000 dollars to 620,000,000 dollars. He said that during the same period trade with Great Britain had increased from 100,000,000 dollars to 205,000,000 dollars; shipping arriving in and departing from Canada, from 23,000,000 tons to 37,000,000 tons; and railway mileage from 16,550 miles to 22,452 miles, carrying a

traffic which rose from 25,300,000 tons to 63,866,000 tons. During the same period the deposits in the savings banks increased from 63,963,000 dollars to 90,264,299 dollars, and the deposits in the chartered banks from 201,000,000 dollars to 589,000,000 dollars, while business failures had decreased from 13,000,000 dollars to 11,600,000 dollars.

Immigration and Settlement.

Under this head it is interesting to note that by the last census returns immigrant families settled on land in Canada in 1906 had an average of four horses, twelve cattle, five swine, and possessed an average acreage of 208 acres of farm, with 49 acres in crop. One-third of those succeeding had not farmed before going to Canada.

I suppose no one will question the statement that the essentials of the Dominion continue to be more methods of transportation and more people. Over one hundred new town sites on railway lines were put on the market last year. These places appear as a speck on the bald prairie, and with almost magical rapidity, some of them at least, become centres of distribution and prosperous villages, filling the needs of the settlers in the surrounding districts. Railway construction is proceeding rapidly, but even one thousand miles a year does not keep pace with settlement. In the prairie provinces free homesteads of 160 acres are given by the Government to every male over 18 years of age, British or Canadian born, or an alien, who, after three years' probation, swears allegiance to the British Crown. During 1908 the homesteads and pre-emptions taken up, if packed close together in a space twenty miles wide, allowing only for intervening railway sections, like squares on a chess-board, would make a strip of one thousand miles. I have suggested twenty miles in width, so that no farmer would be more than ten miles from a railway running in the centre.

Much hope is centred on a proposition to build a railway from the prairies to Hudson's Bay, so that while the Hudson Straits are open for four months or more each year, cargo vessels might carry the prairie grain direct to England without breaking bulk. This line, when built, will not, in the opinion of those qualified to judge, be more than an additional outlet for the future production of grain in the central prairie provinces, but sufficient traffic will also be available for existing railways, and the all-water routes, *viâ* St. Lawrence, and Atlantic Ports, Vancouver, and Prince Rupert. About 6,000,000 acres were under wheat in the prairie provinces last year, but the area of land suitable for wheat production south of the Saskatchewan watershed is not less than 171,000,000 acres, according to Professor Saunders, whose estimate is the lowest. One fourth of that area under wheat would supply the British Isles three times over, and Canada's home market as well.

The surface of the prairie provinces is strikingly similar to the tundras of Russia, especially along the westernmost section of the Siberian Railway. The prairies on the banks of the Yenesei equal the fertility of the renowned Red River Valley through Manitoba, North Dakota, and Minnesota, but they are at present too remote from the market to be a possible competitor. The capacity of the prairie provinces to grow wheat has been referred to by Professor Tanner, the eminent British agricultural chemist, in the following words :—

"Although we have hitherto considered the black earth of Central Russia the richest soil in the world, that land has now to yield its distinguished position to the rich, deep black soil of Western Canada. Here it is that the most fertile soil in the world is to be found, consisting of a rich vegetable humus, one to four feet deep."

And on the same question the Editor of *Commercial West* and the *North-West Miller*, in 1905, made a very modest estimate. He said :—

"When the American West was being developed the wheat acreage increased one million acres a year. For a number of reasons the increase will probably not be so rapid in the Canadian West, but it should be about 300,000 acres a year for the next ten years. That would give an acreage of about 7,000,000 acres by the year 1915, and a crop in an average year of 175,000,000 bushels."

In Western Canada over 7,000,000 acres will be under wheat in 1909.

There appear from time to time new districts claiming consideration, and there is a distinct northern trend in wheat cultivation. Last year one farmer at Fort Vermilion, hundreds of miles north of the Saskatchewan water-shed, grew thousands of bushels of magnificent wheat, which is now being ground into flour by the Hudson's Bay Company at that point. Wheat weighing 62½ pounds to the bushel has been successfully grown at Fort Simpson, 818 miles north of Winnipeg, and the continuation of the Grand Trunk Pacific Railway into the Yukon territory will bring into direct

communication a district which even now is raising a large quantity of vegetables, &c., for local use. I am aware that in the further north the possibility of frost becomes more certain, but when one recalls how the State of Kansas sixty years ago suffered annually from summer frosts, and that cultivation has driven the frost line backward, a similar effect would not seem strange in Canada, where still vaster areas are being opened up, and where, indeed, the frost line has been set back hundreds of miles already. What shall be the end when it is remembered that north of the Saskatchewan water-shed I have mentioned, and including Ungava, Keewatin and Mackenzie, the extent of this practically unknown land is over a thousand miles across, and north of Winnipeg Lake itself there is an area only partially explored, of from five to ten thousand square miles, adapted to agriculture? I recommend the perusal of the recent report to the Senate of Canada on "Canada's Fertile Northland," issued by the Minister of the Interior.

The trend of settlement in Canada, as was the case in the States, has been westward, following, and in many cases preceding, the construction of railways. As the land in the present railway belt (the more southern part of Western Canada) is being rapidly filled up, attention is being directed to the great northern reserves for other purposes than merely grain growing. The Director of the Geological Survey of Canada reports:—"Ungava possesses a belt of iron-bearing rock, probably one hundred miles long, and two or three hundred miles wide, and, in the future, Labrador will furnish a large supply of iron."

If the United States did not largely use maize for food, her present supply of wheat would not exceed the total needs of her inhabitants. That is a strong statement, but true, and shows a future near market of such capacity that may absorb all the surplus wheat Canada can produce for some years. The President of the Great Northern Railway states, that the price of wheat will never be substantially lower, and that in a very few years' time the United States will be importing, instead of exporting. The President of the Canadian Pacific Railway Company says:—

"As regards the shrinking of the American exportable surplus of wheat, there are three main factors to be considered—(1) The debilitation of the wheat areas in the Western States; (2) the increase of population; and (3) the fact that maize (the pivotal American crop) is here and there taking territory and capital from wheat."

The Special Agent of the United States Department of Trade and Commerce reported, after a lengthy investigation in Canada, that in his opinion the year 1910 would see 150,000,000 bushels of wheat grown in Western Canada. With over 7,000,000 acres under wheat in 1909 he may reasonably be correct.

These statements seem to surprise American citizens, for we find the Rev. Joseph Cook, the well-known American clergyman, lecturing recently before the Boston Club, speaking as follows:—

"Let us not underrate the British States of North America. It has been my fortune, in Manitoba and in British Columbia, to meet with experiences which have given me a new conception of the dignity of the Canadian Dominion. Conversing with a professor of a university in the beautiful and energetic City of Winnipeg, while a map of North America was opened before us, I put my compasses down, one foot on St. Paul, and left the other swinging about the chart. 'Now,' said I to my informant, 'how far north must I carry this loose foot of the compass to reach the furthest border of your good wheat lands?' 'You must carry it north,' said he, 'to the Peace River in Athabasca. On the banks of that stream the buffalo and their young may be seen feeding on grass on the 10th of May.' I opened the compasses until they reached the Peace River, some 1,500 miles north-west of St. Paul. I then swung the compasses around, and their northernmost point, when carried east, stood in the Atlantic Ocean, and when carried to the south it stood in the gulf. Incredible as the assertion may appear, there is more arable land north-west of St. Paul than east of it."

Apparently Canada's reputation has also taken firm hold in Italy, as appears by the following translated extract from a well-known journal there:—

"Fortunately the cultivation of wheat has for the past few years been developed to an extraordinary degree in the fertile and boundless plains of Western Canada, and the production is all the while increasing. The day is not very far distant when Canada, cultivated with eager industry by the robust arms of the immigrants crowding in, will become the granary of the world, as Egypt was of the Roman Empire."

Manifestly men and money are a combination that mean production and transportation of agricultural and manufacturing products, and consequent prosperity. A much larger number live on the land in Canada than in Great Britain, and her ambition is to continue along similar lines in the future, consequently emigration to Canada is a vital and desirable necessity. Those engaged in emigration work sometimes meet with a chilly reception from those who feel that people should be retained

here. Statistics show that a million babies are annually born in England, and the capacity of the British Isles to absorb that additional number each year by her commercial enterprises is not apparent. Therefore, some people have to move. During the past seven years 920,220 persons left British shores for America, while 519,845 left for Canada in the same period. I submit that it is doing good work for the Empire when Canada offers an avenue for livelihood to those who cannot find it here, and tries to divert, if possible, those intending to go to the United States. Canada is not in the "little Empire" class. If Britishers will not go to Canada, then it is hoped that they will go to some other part of the British Empire, but not out of it. Canada, however, can care for all genuine workers, with the assistance of British capital, and the diversity of occupations in the Dominion means that the immigration policy must be sufficiently elastic to meet the constantly changing conditions. The present Minister of the Interior very aptly said:—"The policy of immigration cannot be measured with the tape line, nor fitted to the multiplication table, any more than water can be measured by the yard, or peaches by the acre"

What has immigration meant to Canada up to the present? Population in 1891 less than five millions, now seven millions; the production of apples, grapes, and other fruits more than doubled, grain and field crops nearly trebled in the same period; 216,000 farmers settled on free homesteads requiring agricultural machinery, live stock, and railway development; in ten years the number of new arrivals increased from 25,000 to a quarter of a million per annum. Tens of thousands of American farmers have come to Canada, bringing with them cash and effects worth many millions of dollars. These figures sound tremendous, but in the Appendix 1 I give a sample report of such arrivals at one of the customs ports of entry on the International boundary, and Appendix 2 shows that the American settlers arriving there in 1908 made Canada richer by 65,000,000 dollars.

Canada has not balanced her account with America yet, for there are over a million Canadians, or descendants of Canadians, in the various States of the Union, driven there years ago by adverse conditions, which happily do not now exist.

Canada's population is 73 per cent. rural and 27 per cent. urban; her volume of trade has more than doubled in ten years; her relative percentage of commercial growth for seven years was 107 per cent. against 47 per cent. for the United States and 26 per cent. for Great Britain; land values have quadrupled in the west, yet they are now only one-fourth the price of similar lands in the States, hence the American exodus; 87 per cent. of Canadian farmers own their own lands; nearly two thousand million dollars represents the value of lands and buildings in connection with Canadian agriculture; she sells England more cheese than all other countries combined; her forest products equal one hundred million dollars in value in some years. The Western cattle trade thirty years ago did not exist; now there are at least a million animals at pasture on the western prairies, and twenty thousand different ranching brands are officially registered. Canada has nearly thirty thousand public schools; a greater railway mileage per head than any other country; 767 miles of electric railway; 1,000 lighthouses and lightships; 35 to 40 Chartered Banks, with over 1,500 branches; grain elevator capacity nearly 65,000,000 bushels, including those at Fort William and Port Arthur; and the population of Western Canada has increased in a generation from a few thousands to nearly a million.

Canada is blessed with a preponderating number of the middle working class; she has no aristocracy save that of worth, and very few of the poor so common in the cities of the Old World. If the view of publicists that Russia's downfall may be traced to the absence of the great middle class as a backbone is correct, then Canada is indeed favoured by Nature and by immigration. The duty of the Government is to see that no poor material is admitted to depreciate the high general average of worth in a nation of workers.

At the commencement of the nineteenth century the population of the United States did not exceed that of Canada at the dawn of the twentieth century. It was no small task for the people of the States to settle the immense areas of their Republic. Canada, with her larger area of unproductive territory, has a greater problem to solve, and figure for figure, class for class, is making a much better job of it. To the furthering of this most worthy object the application of British capital can well and safely be applied. "The nineteenth century belonged to the United States, the twentieth century is Canada's." So says Sir Wilfrid Laurier.

Perhaps it is safe to say that Canada's record is unique in her capacity to absorb capital and people, and enlarge her trade tremendously, without wrenching existing conditions at home and abroad. Her banks limited the ambitious investments of reckless customers at a time of financial stress, and although they have been severely criticised, many a man standing on the crest of the wave of prosperity must be grateful for the steadying influence of the man who holds the purse.

With advancing development prosperity is again shining on Canada, and there will come the inevitable increase in immigration. Departmental machinery will help towards satisfactory results, but the country itself, blessed with such abundant natural resources must, after all, be the mainstay of the movement.

The time when the United States abrogated the Reciprocity Treaty with Canada was the time when Canada needed outside assistance, or, at any rate, thought she did. That time is past. Canada has, by the aid of British capital and her own faith, carved her way through obstacles at one time seemingly insurmountable, and now the United States, and other foreign nations, do not leave her out of their reckonings.

Opportunities for British Capital.

Wherein do I see opportunities for safe investment of British capital in Canada? First let me say that, all things being equal, British capital will and should go in preference to some part of the same Empire, for in that kind of union is unquestioned strength. Dependence for food supplies can best be placed with component parts of the same Empire; Canada can be made to supply all Britain's needs, and perhaps in the future (not too distant) she may so far dominate the supply of the very necessities of life to foreign nations, that her say will be a mighty support when danger threatens the Motherland. The force of arms is unfortunately too often illustrated, but many battles are won and lost for Empire and home in the commercial markets of the world by men who make commerce in such a way that the fighting arm of the enemy is paralysed. The pen may be mightier than the sword, but, in my opinion, commerce beats them both.

All federal, provincial, municipal and railway bonds have behind them actual, tangible assets, and will doubtless continue to be favourably considered.

The purchase of unimproved lands for settlement purposes on the great central prairies has given the American many million dollars of profit. British capital still seems very loth to invest in what is one of the best investments to be found anywhere. The American farmer who sells his farm in the States can purchase practically four times the same area in Canada. I also favour loan company securities based on a safe cash value, whether listed on the market here or not. Private investment in mortgages on real estate is safe and remunerative.

Other fields for investment can be found in oyster growing, for home and export; whaling and fish industries; development of water power—(it is estimated that 25,000,000 horse-can be produced); prospecting and mining of coal; silver stocks on a good margin of known development; cattle and horse raising, hog raising, and meat packing; fruit raising in Nova Scotia, New Brunswick, Prince Edward Island, Ontario and British Columbia; lumber mills, pulp and paper making, iron and steel industries, flax growing, linseed oil mills, and binder twine factories; fodder and grain crops for export; poultry, sugar beets, sheep raising, tobacco (one county in Ontario produces six million pounds); iron mining and manufacturing, nickel (Canada has 57 per cent. of the world's supply); gypsum for plaster mills, mica, natural gas (Ontario alone has 392 wells); life, fire, and accident insurance companies; mills to manufacture paper from unlimited quantities of straw; oatmeal and flour mills; soap factories, fisheries, glass factories; agricultural implements and carriages; stoves and hardware; boot and shoe factories, furniture factories; cycles and motor cars, metallic roofing; cotton goods, pickle factories; blasting furnaces and smelters, and the construction of residences, large and small, in the growing towns of the Dominion. For all of the above Canada has the raw material, and an increasing demand.

Industries already generally established that can be further developed by capital, with profit, seem to be gold, silver, lead and other mining, coal mining, iron and other mineral products (the Algoma Iron and Steel plant and the Dominion Steel Company had the biggest March business in their history); factories for canning meat, fish, fruit and vegetables; water powers to supply electric energy for lighting, heating and power; the production of horses, cattle, sheep, bacon, cheese, tobacco, flax, asbestos,

Portland cement, natural gas, lumber and wood products, beetroot, sugar, and the growing and milling of food stuffs.

The rate of interest earned in Canada is, of course, higher than in the British Isles. There are splendid opportunities of investing in loan and trust company stocks. Farmers actually prefer to borrow at 7 and 8 per cent. because their agricultural operations frequently net them 20 per cent. on such borrowed capital. With more farmers each year this field of investment increases, yet I know the directors of a small loan company in Western Canada lending its money on first mortgage to artisans and others owning their own homes at a margin of 50 per cent. cash value, repayable in monthly combinations of principal and interest, who tried (and failed) to borrow 100,000 dollars on ten year debentures at 6 per cent., payable half-yearly in London —apparently because the stock was not listed in London.

American Investments in Canada.

It is stated that not less than 196,357,411 dollars of British capital went to Canada during 1908, and was there invested, as follows:— Dominion and Provincial Government Bonds, 77,598,500 dollars; Municipal Bonds, 47,433,911 dollars; and Corporation or Railway Bonds, 71,325,000 dollars. Of this enormous sum, 84¼ per cent. came from Great Britain, 12½ per cent. was subscribed in Canada (not so bad seeing she has had to sow her farthings and reap her pennies before spending them), and the United States, 3¼ per cent. I must point out that so small a percentage does not represent the amount invested last year by the United States in Canadian industrials, for it is well known that while the British investor has dealt largely in official bonds, the States have been freely placing their money in Canada's greatest industrial assets and natural resources.

Not only this, but the States are pushing trade in Canada along lines which might fairly be considered exclusively Canadian. For example, there was exported into the province of British Columbia alone during 1908, from the United States, butter, cheese, and milk valued at 180,000 dollars; eggs, 67,000 dollars; meat, 741,000 dollars; fruits, 268,000 dollars; vegetables, 134,000 dollars; hops and malt, 88,000 dollars, a total for foreign food, for consumption there, aggregating 1,865,000 dollars in one year.

Canada imports from the States large quantities of automobiles, cycles, clocks and watches, boots and shoes, and iron and steel manufactures, goods which ought to be made in Canada, or supplied by Great Britain.

I consider the estimate of 200,000,000 dollars invested by Americans in water powers and industrials in Canada is not excessive. The following is an extract from the recent report of a special representative of the United States Trade and Commerce Department:—

"The building of the Canadian industries has been due to United States capital. In the case of many industries, substantially all the capital is from the States. In other cases capital is Canadian, while the industries are managed by parties from the United States, and the articles are duplicates of those manufactured in the mills of this country (United States). No trustworthy calculation can be made of the amount of capital actually transferred from the United States to the Canadian industrial enterprises during a given period. An estimate by a Montreal bank manager of the American investments of that city fixed the maximum at 25,000,000 dollars during the past five years, although 75,000,000 dollars had been claimed. It is not, however, the actual amount of the capital that is so important, as the fact that the United States has a direct or indirect interest in so many Canadian concerns, and money is constantly flowing back and forth, some of it in the form of dividends from branch factories, and probably a larger proportion in the form of purchases of raw material and factory supplies. The establishment of branches of American factories on Canadian soil is not recent, but the movement has been very marked during the past five years. Many of these enterprises draw not only their raw material, but machinery parts and partly fabricated materials, from the factories in this country (United States). This is particularly shown in branches of the iron and steel industry."

This statement makes Canadians regret all the more the tendency of the British market to keep so strictly to official bonds, and in this connection I think it important to repeat the opinion of the London manager of the Bank of Montreal:—

"In respect to investment in water-power and industrial securities proper, England—much more Scotland—shows a marked timidity. Generally speaking the Englishman shuns water-power securities, looking upon them as highly speculative industrials, though, as a matter of fact, they are on a higher plane than industrials, in a general sense of the term, being public utility companies, more frequently than not affording most excellent security with good interest return; unlike manufacturing concerns, subject to trade fluctuations and tariff changes, they have a business in perpetuity."

This attitude gives the American his chance, and an opportunity of improving it. It would

be interesting to know why British capital continues to be so largely interested in American railways and similar ventures, when it is now admitted that the limitation of wheat-growing in the United States is already in sight, and, in consequence, railway enterprises will to some extent be checked, while railway construction in Canada is not yet one-fifth of what will be required to develop Canada's resources to an extent equal to those in the States. In this connection it will be well to remember that during the year 1908 the United States lost more people by emigration than they received by immigration.

I am regretfully obliged to admit that the Americans have been securing large interests in industrial concerns in Canada, which would afford British capital exactly the same amount of profit if invested therein. It may be said that this has been done in some cases to avoid the customs tariff, but the fact remains that there are 122 industrial concerns in Canada which are American in origin, and financed with American money, to the extent of probably 125,000,000 dollars. This list I give as Appendix 3; and, in addition, one sees frequent references to Americans negotiating for control of development schemes concerning natural resources. For example, if President Hill, of the Great Northern Railway Company, has not already secured a controlling interest in the Crow's Nest Pass Coal Company, in which district it is estimated there is sufficient coal, if mined at the rate of 4,000,000 tons a year, to last for 500 years, it is not for the want of his trying to do so; and I think it may be accepted as a fact which is much to be regretted.

Again, a party of Nebraskans, headed by President Drake, of the Standard Bridge Company, and Manager Jameson, of the Mountain Lumber Company, Oregon, are seeking timber propositions in British Columbia, and apparently have secured some, while an old-established lumber company in British Columbia, with three new saw mills in full operation, showing 17 per cent. profit, could not find a purchaser at par, or anything else, in Great Britain, during the last six months.

Gold in any considerable quantity in British Columbia, was first discovered in 1848 in Queen Charlotte Island, off the coast of British Columbia. For years attempts have been made to interest British capital in the gold deposits there, and in the enormous area of excellent coal in those islands, without success. Within the last few months this coal has passed into the hands of Americans, who need it for the purposes of the United States, and are thus able to supply the American war vessels and their mercantile marine with a commodity that cannot be found on the Pacific slopes of the American Union. Of 1,800,067 tons of coal produced in British Columbia in 1907, 673,114 tons of coal, besides 60,110 tons of coke were exported to foreign countries, and British Columbia sells with profit in San Francisco, notwithstanding the heavy import duty there.

An American syndicate has acquired a central location in the city of Toronto, and is about to erect thereon a palatial hotel, costing a million and a half dollars.

The whaling industry in Canadian waters between Herschell Island and Cape Bathurst, and at other points, is monopolised by Americans and their capital. A New York syndicate, headed by Mr. W. R. Hurst, have recently acquired an area of pulp wood in Newfoundland, and intend erecting a ten million dollar plant, capable of producing 450 tons of paper per day. The halibut fishing industry on the Pacific coast is carried on principally by an American company, whose last year's catch was worth two million dollars.

Even ancient relics are not free from the desire of our American cousins. During last month they secured from Canadian owners the boiler and other parts of the steamer *Beaver*, the first steamboat to ply in regular trade along the Pacific coast. Although the boiler was not the original boiler that came round the Horn, this did not prevent them from setting these relics up with great pride as a permanent attraction in the city of Seattle.

A.B.C. Route for Grain.

I desire to call special attention to what is sure to become an important alternative trade route. I refer to the A.B.C. route for Canadian grain, so called from the combination of the initial letters of Alberta and British Columbia. Since the great increase in grain growing in the province of Alberta, the comparative cost of transporting the grain over the long railway journey, eastward from Calgary to Lake Superior, a distance of 1,260 miles, against 644 miles westward from Calgary to Vancouver, has become a live question, if Alberta wheat is to have the same chance in the world's markets as that grown in Saskatchewan and Manitoba. The western route, *viâ* Vancouver

and Cape Horn or Suez Canal, is open all the year, while most of the grain hauled in winter time from the prairies eastward is stored at Lake Superior points until the spring. Comparing the winter rates, it is found that the rate on grain from points on the Calgary and Edmonton Railway to Lake Superior is 25 cents. per hundred pounds, and by rail from Lake Superior to West St. John, Boston, or New York, 25 cents more. The water-rate on the Atlantic varies from 5 to 7 cents, which makes a through Eastern rate to Liverpool and London not less than 55 cents per hundred pounds. West-bound the rate is 22½ cents from all Canadian Railway Pacific stations in Alberta to Vancouver, and the Chargeurs Reunis line, operating freight steamers to Liverpool *viâ* Cape Horn, have quoted a grain rate of 22½ cents, making the total west-bound through rate to Liverpool and London 45 cents (a saving of 10 cents per hundred pounds), but at present there are no elevators at Vancouver to permit the loading of grain in bulk into steamers, so the saving of 10 cents per hundred is largely used up in the cost of sacking the grain. It is understood that a similar rate to Europe can be made *viâ* the Suez Canal. Vancouver is under no special disadvantage, as all grain forwarded from San Francisco, Portland, Tacoma, and Seattle is shipped in sacks. There is no elevator at any of these ports for handling grain in bulk, and Vancouver is likely to have, through the enterprise of the Canadian Pacific Railway, the first shipping terminal elevator on the North Pacific coastline. If 10 cents per hundred pounds advantage can thus be obtained for Canadian wheat in freight rates, thereby saving the cost of storing and insuring the grain for the winter, it will be worth while indeed. It is quite within the range of possibility, with up-to-date methods of handling, and increased competition for the trade from Prince Rupert and Vancouver, that the point where the advantage will disappear, or nearly so, between East and West shipments will be set eastward as far as Moose Jaw, and thus affect the profits of wheat-raising on all the central prairies.

The distance from Vancouver to London by the Suez Canal is 15,200 miles; *viâ* Cape Horn and the Straits of Magellan 14,200 miles, and when the Panama Canal is opened the distance will be reduced to one-half. A continuous stream of grain westward to the Pacific Coast could not fail to stimulate return cargoes, and the quicker returns consequent upon an all-the-year market must be beneficial to the Canadian farmer, and a strong incentive to immigration and commercial enterprise; yet the shippers of grain westward must exercise care as to the quality, as only special grades can at present be sold at Pacific points.

Not only does there appear to be immense need of capital to develop the A.B.C. grain route, but trade with the Far East and Mexico from Canada is increasing, and capable of still further development. I attach as Appendix 4, a statement showing the trade of Canada with China and Japan during the past ten years, from which it will be seen that while the imports from China and Japan in 1908 scarcely exceeded those of the ten previous years, the exports to those countries from Canada have more than trebled.

Although the native Mexicans are not consumers of wheaten bread, and subsist on rice, corn and beans, there has been latterly an increasing demand for Canadian wheat, sufficient to induce the Mexican Government to take off practically the whole of the duty on foreign wheat going to Mexico. This has created some trade, but while it is not considered by those in a position to judge, that Mexico will, to any very considerable extent, afford a permanent market for Canadian wheat, one cannot foretell the ultimate result of the great international development that will take place when the Panama Canal is opened for traffic. The past two years have been exceptionally dry, and the native crops in Mexico have been largely a failure. In 1905-6 Mexico bought four and a-half million bushels of wheat from Texas, but this year Texas was short, and Canada made her first shipment. Dry seasons will occur again, and Mexico will want wheat, and more and more the Pacific Coast States will cease to be exporters, requiring all their crop for their own use. Then Canada's opportunity will arise to secure what trade there is.

I have not touched upon the export of flour from Alberta mills to the Orient, but evidently those interested believe in the prospects of profitable trade, because 43 more elevators and additional flour mills are to be built in Alberta this year.

For years Canada has been shipping lumber from Vancouver to Japan, China and Manila, and within the last month has even made a shipment to Calcutta.

During 1908 the ship tonnage cleared at the Port of Vancouver exceeded three millions, which is in excess of the Puget Sound ports.

and compares most favourably with San Francisco, and in point of total tonnage with Montreal, though not in value of trade.

Extracts from an article on Canadian trade with Australia, in *The Westminster*, Toronto, of February, 1908, and written by a former official of the Canadian Manufacturers' Association, appear in Appendix 5.

Development of Pacific Trade.

To a large extent what has been said refers to present conditions and those of the immediate future, but I desire earnestly to call the attention of those interested to the tremendous possibilities of trade development on the Pacific Ocean when and so soon as the Panama Canal shall be open for traffic. Even now negotiations are pending for the carrying of freight from Vancouver in Canada to England by utilising the Tehuantepec Railway, and were the gradients of that short railway not so difficult it would be a very serious competitor with other lines of transportation.

Professor Chisholm, in the third edition of of his "Commercial Geography," says:—"If British commerce has in recent years advanced with less strides than that of some other countries, geographical ignorance on the part of merchants and business men can be set down as one of the principal causes." I do not consider that Canadian business men are any more free from the suggestion of geographical ignorance, but I would suggest a serious study of the new conditions that are even now arising upon the Pacific Ocean.

The development of coast-wise and overseas shipping and commerce between countries bordering on the Atlantic Ocean was an achievement of the nineteenth and preceding centuries; the opportunity of the Pacific has arrived with the twentieth century. The opening of the Panama Canal, fraught as it will be with vast importance to the commercial interests of America, cannot be ignored by British capital, and future results may be nearer realisation than we think. The leading Pacific Coast newspapers joyfully assert, that "Taft's administration will see vast developments, particularly in the regions facing the Orient."

Geographical conditions oblige us to look to the maritime importance of British Columbia for the best evidences and future possibilities for Canada in the Pacific trade. The ports of Vancouver, Victoria, and Prince Rupert are destined to play an important part in the development of the Canadian Dominion. A few facts will suffice to show that there is the substantial backbone of natural resources to the ever-increasing trade now passing through British Columbia, which it is sincerely hoped will be manifolded when the vast possibilities of profitable enterprise become known to the man with the purse.

British Columbia has 182,000,000 acres of timber lands, only 16,000,000 of which have been alienated, the balance being wisely put under reserve by the Provincial Government. The 160 saw mills in the province manufactured, in 1907, 846,000,000 feet of lumber, of which 67,000,000 feet went to the United Kingdom, South America, South Africa, China, Japan, Germany, Fiji, Mexico, Australia, Chili, Peru, and India, and these points very generally indicate the trade connection the States have from their ports on the Pacific.

On Vancouver Island the Naniamo coal measures cover 200 square miles, and those of Comox 300 square miles, the latter having, it is estimated, workable coal to the extent of 6,000,000 per square mile. Canada has practically the only readily available supply of good coal on the whole Pacific coast, and yet already some of this has been alienated to Americans.

The imports and exports of British Columbia amounted to 28,000,000 dollars in 1904, and increased to 48,000,000 dollars in 1908. Wheat has been shipped every year from Portland, Tacoma and Seattle to the United Kingdom, and other parts of Europe, but coming events will render it incumbent on Canada not only to supply an increasing amount of foodstuffs to Europe and the Ear East, but, in effect to monopolise the whole grain trade on the Pacific coast, because of the inability of the United States to increase her wheat crop beyond the needs of her own people. Obviously, Canada can concentrate a large percentage of the commerce of the North Pacific at least, for her own ports.

Regular steamship communications exist from British Columbia ports to China and Japan, Honolulu, Australia, Alaska, and for 4,350 miles to Dawson City in the Yukon. There is also a coastal service to Puget Sound ports, San Francisco and Mexico. With the opening of the Panama Canal the whole feature of the Pacific trade will be changed. The United States is not spending 300,000,000 dollars on that waterway for nothing. The saving from San Francisco to New York by water will be 5,100 miles, and the saving from

New Orleans to the Golden Gate, nearly 8,000 miles over the present all-water route.

Already, as I have stated, an attempt is being made to ship to and from British Columbia by way of the Tehuantepec Railway from the Gulf of Mexico to the Pacific Ocean. It is true that that line has heavy gradients, but it is only 192 miles long. Consideration will show some of its comparative advantages over present routes. For instance, from Liverpool to Montreal, thence to Vancouver, would be 2,772 miles by water and 2,906 miles by rail. From the Gulf end of the Tehuantepec Railway to Liverpool is 3,596 miles, and from the other end of this short line Vancouver is 4,020 miles by water, or by this route 7,616 by water and 192 miles by rail.

Somewhere on the Alberta and Saskatchewan plains is a changing point, east of which it will be more profitable to ship wheat to Atlantic ports, and west of it *viâ* Pacific ports, and this line will be set nearer Winnipeg when the Panama Canal is opened. It is quite certain that a new route would mean the moving of wheat every month of the year, and keep the supply to this Motherland steadily flowing.

Mr. Mann, Vice-President of the Canadian Northern Railway, stated a few months ago, that the productions of the whole of Alberta and of Saskatchewan, as far east as Battleford, would probably find their natural course to Europe *viâ* the Panama Canal; and Mr. Charles M. Hays, General Manager of the Grand Trunk Pacific Railway, is of the same opinion. Mr. J. J. Hill, of the Great Northern Railway, said, "The effect and possibilities of the Panama Canal route cannot be surmised."

When at the Pacific coast last month, Mr. William Whyte, second Vice-President of the Canadian Pacific Railway, said, he believed that Alberta export wheat is all destined to go through Vancouver, probably in sacks, by the Tehuantepec route rather than round the Horn. All these transportation experts appear to be alive to the situation, and the man with the capital must not be surprised at extensive calls for money.

There is trade in fish and other commodities, ready for development, between Canada and the Catholic countries of North and South America on the Pacific, and, when the Panama Canal is open, with Atlantic ports in North as well as South America.

The total value of goods sold by the United States to Canada last year exceeded the total value they sold to the whole of South America and Mexico combined. They want all the trade of the west coast of South America, and will try to get it.

If anything more is needed to point the importance of the situation, I would quote the following from the speeches of Mr. Theodore P. Shonts, Chairman of the Isthmian Canal Commission. In speaking of his holdings in the Tennessee Coal and Iron Company, Mr. Shonts said:—

"When the Panama Canal is completed, every (100 dollar) share of my stock in that company will be worth 1,000 dollars. The opening of that canal will make Birmingham, Georgia, the Pittsburg of the South, and will give it the same relationship to the Gulf of Mexico that Pittsburg now has to the Atlantic coast.

"The Panama Canal will be open for traffic in 1915, and I estimate the volume of traffic passing through it the first year will amount to 7,000,000 tons.

"If conditions were to remain permanently as they are to-day, there might be a doubt as to the wisdom of this expenditure; but when we look around and see the rapidly increasing population and resulting density of traffic in our own country, when we observe that our vast transportation facilities, which made possible our country's wonderful expansion and form the underlying basis of our prosperity, are simply swamped with the traffic which they are called upon to handle, and when we contemplate the enormous amount of money that must be raised to provide adequate facilities for taking care of the increased volume of business, we are compelled to conclude that the superfluous population of the earth will soon be forced into other channels than the United States, and is not unlikely to move into the vast fertile plains and rich regions of our South American neighbours.

"Hence it is our duty, if we expect to get our share, to set forth immediately and systematically to develop means to acquaint ourselves with their needs, so that when the canal is opened and ships can go from our home ports to the ports of the west coast of South America without breaking bulk, we may be able to take advantage to its maximum possibility of this physical transformation of the earth.

"If our prosperity is to continue, we must have wider markets for our goods—what better fields for exploitation exist than the territory of our next-door neighbours in Central and South America? But while it is necessary to have the markets in which to sell our goods, it is equally necessary to have the facilities with which to transport them. I mean by this that the volume of our export trade to-day is seriously hampered by the overtaxed condition of our railways, especially at terminal points; in fact, it is a serious question whether it has not reached its limit under present conditions."

And from the positive side of the case the following extract from an official publication

of the British Columbia Government, published some years ago, has a special interest now:—

"Communication and the exchange of products with Australia and the Orient will continually improve, the exports and imports of the province itself, and of Eastern Canada through her ports, must increase very considerably until something like a balance of population and trade on Atlantic and Pacific shores has been arrived at. It would be difficult to estimate the extent which the commerce of British Columbia will have reached by that time. Situate as it is, the only British possession on the eastern shores of the Pacific Ocean, and sharing with its next-door neighbours on Puget Sound in the only first-rate harbours north of San Francisco, a very great proportion of the whole volume of possible trade must be transacted through her ports. At the same time, she possesses every requirement for the construction of vessels whether of wood or iron, and since so large a number of her inhabitants are drawn from the nautical classes, it will not be surprising if she holds her own, both in the building and manning of ships, against all competitors on this side of the the world.

"It must not be forgotten that the Dominion holds the quickest route to China and Australia by several hundred miles, which in these days, when so much store is set upon quick transit of goods, is no small advantage; and it would indeed be an extraordinary reversal of all past traditions if British merchants failed to make use of their opportunities or to compete with something like success against their energetic neighbours in the States."

Conclusion.

Everyone who has the welfare of Canada at heart would deprecate any suggestion or attempt to offer for investment of capital anything but a safe and sound enterprise, and I heartily endorse the following statement by Mr. E. R. Wood, Vice-President of the Dominion Securities Corporation, Ltd.:—

"It may not be amiss at the present time to reflect that while one cannot but feel enthusiastic at the possibilities of this combination ot British capital and Canadian opportunity, yet the situation carries grave responsibilities. We must meet the British investor not merely with the good faith to which his confidence and enterprise entitle him, but with such abundant good faith as shall keep our financial reputation second to none. There must be no 'sharp' practice. A securities market, like any other market, can be spoiled by dishonesty. The magnitude of our needs shows that to spoil it would be a national calamity, and would put back the hands on the dial of progress for a generation. Every bond and every form of security offered the British investor, must bear the stamp of honesty. Canadian securities must win a name in the British market, as Canadian cheese, Canadian apples, Canadian bacon, and Canadian wheat have established their standing. In this crucial stage of our development, I venture to say that the reputation of our securities is of greater moment than the reputation of our material products, important as they must always be. It rests with all issuers of securities, with every bond dealer, broker and financier, with every financial corporation, with every municipal council, and in a more important sense with every Provincial Legislature and with the Dominion Parliament, to see that the man who ventures his money in a Canadian enterprise, is treated fairly and honestly. If there should be an occasional failure, let it be an honest failure, and in every success let the investor enjoy the full benefits of his enterprise. Canada must fully sustain the confidence of British investors."

And with this I close my paper.

Appendix I.

Arrivals from United States *viâ* Gretna, one of the Boundary Customs Ports.

An average value of 300 dols. in effects to each person—all provided with cash and live stock.

Gretna, Manitoba, April 8, 1909.—As giving an idea of the class of people coming into Canada this season from the States, a list has been compiled by the Customs officials here. The total to April 1 was 64 cars of settlers' effects, 198 persons, 264 horses and 102 cattle, with a total value of 60,000 dols., an average of 300 dols. to each person, man, woman and child. The list indicates the name of the new settlers, where they hailed from and their destination; also the number in the family, the cattle, horses and sheep, and the cash they are bringing in, as follows:—

Name of Immigrant.	Number in family.	Horses.	Cattle.	Sheep.	Cash.
					Dols.
James Muson, Laydon, N.D.; Paynton, Sask.	4	2	..	..	800
F. C. Draper, Grand Forks, N.D.; Stettler, Alta.	2	5	..	..	1,500
W. W. Osnes, Ihlen, Minn.; Camrose, Alta.	9	3	..	..	1,100
L. Kohlman, Appleton, Minn.; North Battleford	1	4	6	..	1,150
I. B. Gummro, Ovan, Minn.; Colendzo, Alta.	4	3	..	..	750

APPENDIX I.—(*continued*).

Name of Immigrant.	No. in family.	Horses.	Cattle.	Sheep.	Cash.
					Dols.
Josh Eveman, Iblens, Minn.; Camrose, Alta.	2	4	..	..	1,100
A. Anderson, Minneapolis, Minn.; Edgerton	1	3	..	..	725
O. Stevenson, Parkston, Minn.; Weyburn	1	..	7	6	450
F. Walse, Parkston, Minn.; Weyburn	3	6	4	..	1,150
A. J. Kippon, Grant, N.D.; Winnipeg	3	..	..	..	600
J. Brynildson, Bang, N.D.; Govan, Sask.	1	..	1	2	335
D. S. Mark, Ogeta, N.D.; Stavely, Alta.	1	9	..	..	16
O. Helgerson, Harman, N.D.; Pilot Mound, Man.	1	10	..	..	11
S. Soewing, Hensel, N.D.; Elbow, Sask.	1	5	..	3	8
John Goodman, Mechlin, N.D.; Wynyard, Sask.	3	..	9	..	800
Steve Goodman, Mechlin, N.D.; Wynyard, Sask.	1	3	4	..	710
S. S. Grimson, Garder, N.D.; Wynyard, Sask.	5	4	2	..	1,110
Otto Gratins, Pekin, N.D.; Deslile	3	8	..	..	1,800
F. L. Gratins, Pekin, N.D.; Deslile	5	1	3	..	800
R. Graham, Neche, N.D.; Shanawan, M.	6	7	1	..	1,845
T. Guthrie, Fergus Falls, Minn.; Stettler, Alta.	5	3	1	..	850
Fred Garling, Hanley Falls, N.D.; Elbow, Sask.	7	4	1	..	780
Isaac Radford, Elkwood, N.D.; Wilkie, Alta.	5	5	3	..	930
R. B. Preston, Clarmont, S.D.; Warner, Alta.	1	6	..	..	840
S. Haight, Osnabrook, N.D.; Keeler, Sask.	5	6	..	..	1,150
H. C. Clyde, Barnsville, Minn.; Eyebrow, Sask.	2	5	2	..	975
T. McBride, Milton, N.D.; Gull Lake	7	5	1	..	1,065
J. R. Stephenson, Milton, N.D.; Gull Lake	1	4	2	..	725
J. Avetsgard, Appleton, N.D.; Macome, Sask.	1	5	..	..	1,050
R. Hickey, Portland, N.D.; Macome, Sask.	4	5	..	..	11
D. S. Blair, Ogeta, N.D.; Staveley, Alta.	1	8	2	..	1,560
A. Taylor, Fargo, N.D.; Wynyard, Sask.	1	11	1	..	1,500
C. Christianson, Monton, N.D.; Wynyard, Sask.	1	4	..	..	600
Max Fjarnson, Monton, N.D.; Wynyard, Sask.	2	..	..	..	400
Joel Meyrs, Park River, N.D.; Laconville, Sask.	3	6	2	..	1,160
E. Church, Inkster, N.D.; Lethbridge, Alta.	8	..	3	..	650
Otto Schroedr, Lester, Iowa; Newtain, Alt.	5	4	..	..	775
James Orr, Gluston, N.D.; Minty, Sask.	4	4	2	..	11
S. Gills, Gluston, N.D.; Minty, Sask.	1	5	1	..	775
W. Bide, Gluston, N.D.; Minty, Sask.	3	6	1	..	845
H. E. Jonneson, Hanley Falls, N.D.; Elbow, Sask.	2	5	2	..	800
Ida Othr, Clark, N.D.; Dun, Manitoba	1	4	..	..	700
L. O. Ferth, Cavalier, N.D.; Neelly, Sask.	6	..	..	..	3
Theo. Rollag, Siestan, N.D.; Taber, Alta.	1	4	6	..	1,050
H. Rollag, Siestan, N.D.; Taber, Alta.	3	4	6	..	900
J. Rollag, Siestan, N.D.; Taber, Alta.	3	3	7	..	650
O. H. Rollag, Siestan, N.D.; Taber, Alta.	2	5	6	..	1,000
S. D. Rockfellow, Sarles, N.D.; Swift Current	2	4	1	..	1,125
Emil Peltier, East Grand Forks, Minn.; Lethbridge	12	1	1	..	500
C. K. Patterson, Two Harbours, Minn.; Stettler, Alta.	5	..	..	..	600
Hans Olsen, Park River, N.D.; Herbert, Sask.	3	5	2	..	1,440
A. Kirkpatric, Hope, N.D.; Saskatoon, Sask.	6	6	..	..	1,060
D. McIvor, Hagel, N.D.; Carman, Man.	3	..	1	..	350
C. P. Pope, Avoca, Iowa; Saskatoon, Sask.	2	5	..	..	700
W. Derkert, Avoca, Iowa; Scott, Sask.	7	10	6	..	1,850
B. F. Crellin, Morris, Ill.; Manitou, Man.	4	5	..	..	1,300
J. Leeweak, Perkins, Iowa; Macleod, Alta.	4	7	6	..	1,700
A. Nelson, Buxton, N.D.; Viscount, Alta.	2	6	..	..	1,800
W. T. Hutten, St. Thomas, N.D.; Bergen, Alta.	1	7	..	..	825
W. W. Walsh, Crookston, Minn.; Gleichen, Alta.	4	5	..	..	1,350
S. Gilmer, Howard Lake, Minn.; Hardisty, Alta.	1	5	..	..	1,200

Appendix II.

Statement of Number of Immigrants and Value of Effects for Calendar Year 1908, compiled from the Agents' Reports

State.	Period.	No. of Immigrants.	Value of Effects.
	1908.		Dollars.
Michigan	Jan., Feb., Mar.	659	614,450
	Apr., May, June	853	702,900
	July, Aug., Sept.	618	463,900
	Oct., Nov., Dec.	316	240,500
		2,446	2,021,750
	1908.		
Montana	Jan., Feb., Mar.	371	862,500
	Apr., May, June	400	909,625
	July, Aug., Sept.	420	824,315
	Oct., Nov., Dec.	244	331,780
		1,435	2,928,220
	1908.		
Illinois	Jan., Feb., Mar.	161	377,350
	Apr., May, June	162	86,550
	July, Aug., Sept.	175	166,850
	Oct., Nov., Dec.	51	42,400
		549	673,550
	1908.		
Massachusetts	Jan., Feb., Mar.	192	117,900
	Apr., May, June	399	221,125
	July, Aug., Sept.	219	85,325
	Oct., Nov., Dec.	56	54,300
		866	478,650
	Total for four States	5,296	6,102,170

An average per capita of 1,152 dollars.

Number of immigrants from U.S.A., for calendar year, 1908, 57,124 at 1,152 dollars = 65,806,848 dollars.

N.B.—It is estimated that 70,000 will cross the border into Canada in 1909 and bring in cash and effects, 70,000,000 dollars.

Appendix III.

List of American Firms with Branch Factories in Canada.

Foley, Lock, and Larson, Belleville, Ont.
Lehigh Portland Cement Co., Brantford, Ont.
American Radiator Co., Chatham, Ont.
Manson Campbell Co., Ltd., Chatham, Ont.
Sutherland Innes Co., Ltd., Copper Cliffe, Ont.
Canadian Copper Co., Dundas, Ont.
Pratt and Whitney Co., Canada, Ltd., Guelph, Ont.
Gilson Mfg. Co., Ltd., Hamilton, Ont.
Berlin Machine Works, Ltd., Hamilton, Ont.
F. W. Bird and Son, Hamilton, Ont.
Canadian Westinghouse Co., Ltd., Hamilton, Ont.
International Harvester Co. of Canada, Ltd., Toronto
Otis-Fensom Elevator Co., Ltd., Hamilton, Ont.
Pittsburgh Perfect Fence Co., Ltd., London, Ont.
Battle Creek Toasted Corn Flake Co., London, Ont.
Spramotor Co., Niagara Falls, Ont.
Bissell Carpet Sweeper Co., Niagara Falls, Ont.
Canadian Ramapo Iron Works, Ltd., Ottawa, Ont.
Library Bureau of Canada, Ltd., Peterboro, Ont.
Quaker Oats Co., Sault Ste. Marie, Ont.
Algoma Commercial Co., Ltd., Sault Ste. Marie, Ont.
Algoma Steel Co., Ltd., Sault Ste. Marie, Ont.
Sault Ste. Marie Pulp and Paper Co., Sarnia, Ont.
Cleveland Sarnia Saw Mills Co., Ltd., Stratford, Ont.
Globe Wernicke Co., Ltd., St. Catharines, Ont.
McKinnon Dash and Metal and Thresher Co., Ltd., St. Catharines, Ont.
Packard, Electric Co., Ltd., St. Catherines, Ont.
American-Abell Engine and Thresher Co,. Ltd., Toronto.
American Watch Case Co., Ltd., Toronto.
Ault and Wiborg Co. of Canada, Ltd., Toronto.
S. F. Bowser and Co., Ltd., Toronto.
Brunswick Balke Collender Co., Toronto.
Canadian Shredded Wheat Co., Ltd., Toronto.
Capewell Horse Nail Co., Toronto.
Commercial Acetylene Co. of New York, Toronto.
Computing Scale Co., Ltd., Toronto.
Dodge Manufacturing Co. of Toronto, Ltd., Toronto.
Canadian Kodak Co., Ltd., Toronto.
Fairbanks Morse Canadian Manufacturing Co., Ltd., Toronto.
Henry Disston and Sons, Ltd., Toronto.
Stewart Hartshorn Co., Toronto.
Michigan Ammonia Works, Toronto.
Reeves Pulley Manufacturing Co., Ltd., Toronto.
Sanitol Chemical Laboratory Co., Ltd., Toronto.
John Underwood and Co., Toronto.
Waterbury Chemical Co., Toronto.
Parke, Davis and Co., Walkerville, Ont.
Ford Motor Co. of Canada, Ltd., Walkerville, Ont.
Berry Bros., Ltd., Walkerville, Ont.
The O. and W. Thum Co., Walkerville, Ont.
Canadian Billings and Spencer, Ltd., Welland, Ont.
Plymouth Cordage Co., Welland, Ont.
Penberthy Injector Co., Windsor, Ont.
Frederick Stearns and Co., Windsor, Ont.
Seely Manufacturing Co., Windsor, Ont.
Allis-Chalmers-Bullock, Ltd., Montreal, Quebec.
Berliner Gramaphone of Canada, Ltd., Montreal, Quebec.
Canadian Buffalo Forge Co., Ltd., Montreal, Quebec.
Denver Chemical Mfg. Co., Montreal, Quebec.
American Tobacco Co., Montreal, Quebec.
The N. K. Fairbank Co., Montreal, Quebec.
Gillette Safety Razor Co., Montreal, Quebec.
"Huylers," Toronto, Ont.
Sherwin Williams Co., Montreal, Quebec.
Walter M. Lowney Co. of Canada, Ltd., Montreal, Quebec.
Simonds Canada Saw Co., Ltd., Montreal, Quebec.

H. G. Vogel Co., Montreal, Quebec.
Vulcan Portland Cement Co., Ltd., Montreal, Quebec.
International Varnish Co., Ltd., Toronto, Ont.
Lumen Bearing Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Quebec.
Berlin Steel Go-Cart, Co., Ltd., Berlin, Ont.
Pratt and Letchworth Co., Brantford, Ont.
Canadian Wolverine Co., Ltd., Chatham, Ont.
Page-Hersey Iron Tube and Lead Co., Guelph, Ont.
Canadian Drawn Steel Co., Ltd., Hamilton, Ont.
Union Drawn Steel Co., Ltd., Hamilton, Ont.
Fowlers' Canadian Co., Ltd., Hamilton, Ont.
Imperial Cotton Co., Ltd., Hamilton, Ont.
Meriden Brittania Co., Ltd., Hamilton, Ont.
The St. Charles Condensing Co., Ltd., Ingersoll.
Ideal Concrete Machinery Co., Ltd., London, Ont.
Aver Incandescent Light Manufacturing Co., Ltd., Montreal, Quebec.
De Laval Manufacturing Co., Montreal, Quebec.
United Shoe Machinery Co., Ltd., Montreal, Quebec.
Schram Automatic Sealer Co., Ltd., Montreal, Quebec.
Canada Nut Co., Ltd., Niagara Falls, Ont.
The Spirella Co. of Canada, Ltd., Niagara Falls, Ont.
The Sanitary Can Co., Ltd., Niagara Falls, Ont.
Oneida Community Co., Ltd., Niagara Falls, Ont.
Standard Ideal Manufacturing Co., Ltd., Port Hope.
Nicholson File Co., Ltd., Port Hope.
Canadian Hair Cloth Co., Ltd., St. Catherines, Ont.
Whitman and Barnes Manufacturing Co., Ltd., St. Catharines, Ont.
Standard Chain Co., Ltd., Sarnia.
Standard Brass Manufacturing Co., Ltd., Sarnia.
Stratford Manufacturing Co., Ltd., Stratford, Ont.
Aluminium and Crown Stopper Co., Ltd., Toronto.
American Chisle Co., Ltd., Toronto.
Arlington Co. of Canada, Ltd., Toronto.
Conduite, Ltd., Toronto.
Coco Colo Co. of Canada, Toronto.
Goldschmidt Thermit Co., Ltd., Toronto.
Murphy Iron Works, Ltd., Toronto.
National Cash Register Co., Ltd., Toronto.
William R. Perrin Co., Ltd., Toronto.
Pratt Food Co. of Canada, Ltd., Toronto.
Queen City Oil Co., Ltd., Toronto.
United Typewriter Co., Ltd., Toronto.
Wrought Iron Range Co., Ltd., Toronto.
Dominion Brush and Mirror Co., Ltd., West Toronto.
Benj. Moore and Co., Ltd., West Toronto.
Galena Signal Oil Co., Ltd., West Toronto.
Canadian Bridge Co., Ltd., Walkerville.
Page Wire Fence Co., Ltd., Walkerville.
Canada Forge Co., Welland, Ont.
Electro Metals, Ltd., Welland, Ont.
J. I. Wing and Co., Windsor, Ont.
Zenner Disinfectant Co., Windsor, Ont.
Peabody Mfg. Co., Ltd., Windsor, Ont.
Lufkin Rule Co., Ltd., Windsor, Ont.

Appendix IV.

Trade of Canada With China and Japan.
(From Canadian Returns.)

Fiscal years.	China.		Japan.	
	Imports from.	Exports to.	Imports from.	Exports to.
	Dols.	Dols.	Dols.	Dols.
1899....	755,990	290,085	2,009,747	135,265
1900....	624,433	256,307	1,762,534	112,308
1901 ..	844,583	510,886	1,620,868	188,683
1902....	489,441	277,309	1,503,731	293,277
1903....	512,167	175,876	1,487,451	325,181
1904....	556,306	226,867	1,998,801	342,116
1905....	550,166	1,009,128	1,914,787	510,925
1906....	540,752	973,150	1,662,929	494,102
1907 (9 mos.)	469,361	334,896	1,658,795	538,548
1908....	724,926	964,793	2,197,159	741,108

Appendix V.

Canadian Trade with Australia
(By T. A. Russell).

Extracts from *The Westminster* (Toronto) February, 1909:—

"Australia is a great buying country; immense warehouses have been erected in all the leading cities, and tremendous stocks of goods are carried at every point. Practically, everything in the nature of manufactured goods has to be imported; consequently it is a market which, in many lines of goods, should be largely canvassed by the Canadian manufacturer, but he must recognise that competition is keen.

"The means of communication at present between Australia and New Zealand and Canada are not very adequate. The Canadian Pacific Steamship Company, operating with the Union Steamship Company, of New Zealand, run a line of mail steamers from Vancouver to Brisbane and Sydney, giving a four-weekly service each way. This proves very efficient for a short, direct route and for mail service, but for heavy freight which has to be sold in close competition in Australian markets, the long over-land haul makes the rate almost prohibitive.

"What is needed very much at the present time for the development of Canadian trade is a line of freight steamers plying from some Eastern Canadian port like Quebec and St. John to Australia direct. If some arrangement could be made to secure sufficient return cargo to make the line at all profitable, it would prove of great assistance to the up-building of Canadian trade in Australasia.

"In addition to this line, the Alley Steamship Company operate a line between Canada and New Zealand. These steamers leave Vancouver every two months and prove of some assistance in maintaining service between Canada and New Zealand itself. The service, so far, has not been frequent enough or dependable enough to prove of the value it should to Canadian manufacturers and exporters.

"My conclusions then are that Australasia with er large natural resources and her comparatively nall manufacturing, presents undoubtedly a large iarket for manufactured goods and that Canadian rms should find an increasing market there, in many ifferent lines. . . . .

"This means that competition from that country keen. In addition to this, large exporting counies, like United States and Germany, have their ares introduced, and, in many cases, quote very lose prices."

Appendix VI.

ome Opportunities for Investment in the Province of Nova Scotia.

There is but one tannery in the province, and iat at Pictou. Halifax would be a very natural ocation for a large tannery. The hides could be rought from South America by water carriage, as ell as from other parts of Canada.

A cannery for the canning of blue-berries and ther fruits.

A factory making a good fertilizer would receive eneral support. There are two or three such factoies in the province, but a largely increased demand.

A mill for the manufacture of paper from pulp vood.

A factory making white wear. There is no such ianufacturing concern east of Montreal.

The Silliker Car Works have continually a large uantity of refuse wood going to waste, which could e utilised with profit in the manufacture of rolling ins, clothes pins, step ladders, &c.

Factory for making cordage and twine for fishing ets.

Improved methods of curing herrings and other fish.

There is no shirt, cuff, and collar industry in any of he maritime provinces. You cannot buy a white hirt that is made east of Montreal.

A furniture factory would have abundant supply of irch and other woods. A furniture factory in Windsor, Ontario, is shipping goods to South America and Australia.

There are large beds of salt at Cheverie and elsewhere, which could be worked with profit, as Nova Scotia is the largest consumer of salt per capita, xcept Norway.

Industries subsidiary to that of the manufacture of teel and iron.

Appendix VII.

The Newer Towns and Villages of the Prairie Provinces have to-day openings for the following trade enterprises:—

7 Bakers.
17 Banks.
8 Biscuit and candy factory
8 Blacksmiths.
4 Butchers.
7 Grist mills
9 Hardware stores.
8 Harness shops.
14 Hotels
3 Implement warehouses.
3 Jewellers.
8 Creamery and cheese factories.
2 Dentists.
13 Doctors and druggists.
3 Dry goods stores.
11 Elevators.
19 Flour mills.
6 Furniture stores.
9 General stores.
3 Livery stables.
3 Lumber yards.
1 Machine shop.
4 Newspapers.
1 Oatmeal mill.
1 Planing mill.
1 Pork packing plant.
1 Soap factory.

Persons interested can be directed to a reliable person in each place.

DISCUSSION.

The Chairman (Lord Hindlip) thought it was an opportune time for the subject of investments in Canada to be put before the British public. The subject presented itself to him rather in the light of a prospectus, and he generally endeavoured to see both sides. In looking at Canada as a field for investment the first thing was to see what was bad in it. "Where is the nigger?" With regard to Canada the "nigger" appeared to be a very small one. He had been struck by the fact that the news agencies through which news filtered from Britain to Canada and from Canada to Britain were too much in the hands of the Americans, most of the news coming through New York, and if the gentleman at the end of the telegraph in New York was of opinion that the news was not sufficiently interesting he probably did not send it on either way. Then also the trades unions in Canada were very much under the control of the trades unions in Western America. Their bark, he thought, was worse than their bite. The Socialistic party in Canada appeared to be a negligible quantity. There was also a disposition, chiefly among the Socialistic element, when the danger of invasion was mentioned, to turn round and say that it did not matter much to them and appeal to the Monro doctrine. That, so far as he could say, was the size of the "nigger" in Canada. The other side of the question were the attractions of Canada, and those to his mind were very large and numerous. In the first place Canada was part of this great Empire, and as far as he could see Canada was absolutely free from any fetters of Downing-street. There was no paralysing influence of any Colonial Office clerk, and no interference of a Minister with a party programme. The Dominion Government and the Provincial Governments were bent on developing the country as fast as possible, and assisting by every reasonable means in their power anyone who wished to invest money or to farm or to start industries, or do anything to assist the country; such people were received with open arms. The province of Alberta seemed to present remarkable possibilities for investment and making money in a very short time. In the Lethbridge country for example the quantity of wheat grown to the acre was very great. During the last three years the average crop had equalled the crop grown in this

country, 32 or 33 bushels to the dry acre, as against something like 12, the average of the United States. In the last returns from the Government farm at Ottawa he believed the average was something like 50 bushels. It was quite true, as Mr. Smith had said, that America would very soon be importing wheat. In two or three years time he did not think America would export any wheat at all, and when it was considered that within probably less than fifty years America would have a population of something like 200 millions, it was a problem where the food was to come from to feed these people. Alberta wheat would have its market to the West, but would also have a market in the United States, and he thought that was where the majority of Alberta wheat would go to in the future. With regard to the various ways of transporting wheat and other products from the Pacific coast to Europe, he had been told the other day that the Tehuantepec Railway had offered a freight of 5s. less from Vancouver to London than the Blue Funnel line had offered *viâ* the Suez Canal. If that was the case it would make an enormous difference to the time taken for goods to get from London to Vancouver. With regard to the opinions quoted by Mr. Smith as appearing in *Truth* many years ago, it seemed to him that some of those opinions were also the opinions of a few people now, although not to the same extent. He had in mind a usually very progressive paper whose City editor was very often inclined unnecessarily to "crab" Canadian securities, because he seemed to think they were analogous to what he called "poker chips" in America. If any one believed that Canada was borrowing too fast, or was asking for more money than she could put up collateral security for, that person had better go to Canada and see for himself. Anybody who had been in Canada even five years ago could have no conception of what was going on in Canada to-day, or of the progress that was being made every year and every month. It was not fair to criticise unless one had tested the country recently, because the situation changed very quickly. The agricultural colleges, the Macdonald especially, and the Ottawa Government, were doing all they possibly could to improve agriculture and to teach the young how to carry on their farms at a profit. Every day experiments were being made with different kinds of wheat suitable for the northern country, the endeavour being to produce a wheat that would ripen and mature a day or two earlier than another variety, a thing that meant bringing thousands and thousands more acres of the northern territory into the limit of the cereal growing territory. The bank clearings in Canada had increased enormously this year, and during the panic in America of 1907 there was no corresponding panic in Canada at all; securities fell but they fell because people had to sell something to carry on. He was quite certain that persons who invested their money in sound Canadian investments could sleep at night in perfect security, more so than they could sleep with their money in some countries, and they would find no enterprising gentleman on the look out for profitable hen roosts.

The Hon. J. H. TURNER (Agent-General for British Columbia) said he was more familiar with the Western Provinces than with other portions of the Dominion, and, therefore, wished to confine his remarks to one or two points in connection with British Columbia. It was believed that the future trade of the Pacific would be quite as great or greater than the trade of the Atlantic, and there were some very striking things in connection with that trade that had occurred during his lifetime. When he went to British Columbia forty years ago there was hardly a steamer on the Pacific, and it took a week to ten days to travel from San Francisco to Victoria. At the present time there were very fine lines of steamers to Australia, China, and other ports, running out of Vancouver and Victoria, and the coasting trade between Victoria and Vancouver and the northern parts of British Columbia and Alaska was also carried on by fine lines of steamers. Another factor was the altered taste of the Chinaman. A very few years ago the Chinese ate nothing but rice, but they had now learnt to eat bread made from wheat flour, and thousands of Chinamen had returned home carrying the taste with them, and to-day wheat and flour were being shipped to China from Canada. There were 400,000,000 people in China, many of whom would in the very near future, he thought, be using wheaten bread instead of rice, and that of itself would make a very important trade across the Pacific. There was also the trade down the west coast of America with Mexico and the other Republics rapidly increasing, and he believed the statement made by the Chairman was quite correct that an offer had been made to carry freight from Great Britain to British Columbia by the Tehuantepec line for 5s. a ton less than the Blue Funnel line. That was a thing which would very greatly affect the trade of Vancouver, and possibly railway rates. He knew of shipments actually having been made by that line, if not at 5s. less, certainly at the same rate as the Blue Funnel line rate. The position of British Columbia made it an important section of the Dominion for the trade of the Pacific. The trade of British Columbia at present was comparatively small, but the population was also small; during the last ten years it had probably doubled. In 1901 Vancouver had 30,000 people; to-day its population numbered 90,000. Other towns were growing as rapidly. Fifteen years ago it was believed that fruit-growing was impossible, but last year British Columbia exported some 4,000 tons of fruit grown on fruit farms that were not in existence seven years ago. On the line of the Grand Trunk Pacific forty years ago the country was considered useless, but to-day friends told him that that country had an excellent climate. It was fairly dry, the cold was not intense, and agricultural

products promised to be very good. Last year, for instance, tomatos ripened in the open air very well, a thing they could hardly do in England. There were thousands of acres of land being opened up for agricultural purposes that were never dreamt of twenty years ago. That was in British Columbia alone; and when it was remembered that the whole of the Dominion possessed such resources and possibilities, there could be no better country for investing ing British capital than Canada. There were many advantages there: the best of laws purely administered and taxation light. As the Chairman had said, anyone with securities in Canada could sleep in comfort, and, he might add, get up in the morning probably to find a slight advance in price.

Mr. CHARLES GROSVENOR ROSS (of Ottawa) said that wheat was the staple industry of Canada, and would continue to be so, because it offered an occupation for a large number of men of limited means. In Alberta, the northern limit of the wheat-growing territory lay much farther north than in Eastern and Central Canada, running into what was at present entirely unoccupied territory. The most magnificent wheat could be grown there. In the year of the World's Fair at Chicago he was living on the stage route between Calgary and Edmonton, and during that time the Rev. Mr. Brick, a missionary from Fort Dunvegin, came down with a small load of wheat on his way to the World's Fair, and that wheat took the first prize against the wheat of the world. That showed what the northern country could do. Canada to-day, he understood, was the only country in the West where "No. 1 hard," the highest grade of wheat, could be grown, and that accounted to a very great extent for the influx of the American farmers from the Northern States. Such men were expert wheat growers and found they could no longer grow "No. 1 hard" in the States, and were going into Canada to grow it. Those men made some of the finest citizens, and were glad to become British subjects. Many of them were returning Canadians. With regard to transportation, a new element had entered into the matter by the building of the Georgian Bay Canal. The route had been surveyed, and he believed the Government had almost decided to start it in the near future. It would run from a point east of Sault St. Marie, northerly to a town called North Bay, and then down the river past Ottawa to Montreal. In the opinion of one of the masters of transportation in the United States, Mr. James Hill, the President of the Great Northern Railway, when the Georgian Bay Canal was built it would drain the freight from the whole of the North Central States as far west as Dacota, so that the wheat instead of passing through the great lakes and the Erie Canal would flow north to the Georgian Bay Canal and thus transfer an enormous amount of traffic in wheat to Canada. That was the opinion of Mr. Hill expressed in a lecture before the Canadian Club of Ottawa. With regard to investments several were very prominent. The first was the application of water-power to electric development both for light and power. There was a huge amount of water-power in Canada that was employing and would employ a very large amount of capital. Another profitable industry was the preparation of pulp wood. The demand for pulp was constantly rising, the States taking large quantities. Recently a number of New York capitalists had acquired 100 square miles of pulp forests in Newfoundland, and he thought Lord Northcliffe had also acquired considerable holdings there. In New Brunswick, Nova Scotia, Quebec, and Ontario there were large areas of pulp wood waiting for the saw. Another investment was the silver mines of Cobalt in Northern Ontario, one of the greatest silver fields in the world. These would repay careful investigation. Then there was the need of money in the West. He had written to a friend of his in the West and asked him to tell him the present condition of finance in Alberta, and in reply it was said that there were exceptional opportunities for the investment of outside capital, and capitalists were just beginning to have their eyes opened to the fact that money could be readily invested there in absolutely safe securities bearing 8, 9, or even 10 per cent. interest; that those who had realised the fact were reaping large profits; that during the past ten years the writer had invested for people living in England and Eastern Canada about 100,000 dollars, most of that money having been lent to farmers at 8 or 9 per cent., and secured by a first mortgage on land, and in no case had the amount of the loan been greater than 50 per cent. of the sum which the farm would realise at a forced sale; and that of all the moneys entrusted to him not one dollar had been lost either of principal or interest. That was a splendid example, seeing that some of the investments were made ten years ago. The writer of that letter was a personal friend of his, and he was sure that everything he said was perfectly true.

Mr. F. B. VROOMAN (of Victoria, B.C.) paid a tribute to the work of Mr. Smith in Canada, especially in connection with the emigration department. He himself had travelled throughout the length and breadth of Canada, and had taken pains to look into the economical resources of the country. It was a marvellous portion of the Empire, and so attractive to him that he had not only invested money n the country, but had invested his family and himself, and established a home, in Victoria on the Pacific coast. He had done that for several reasons; first, one felt in getting into a country like that that one was in the game—in one of the biggest games being played by the Anglo-Saxon race to-day or any other race. He had seen wheat growing on the Brick Farm on Peace River the finest he had ever seen, and similar to that mentioned by Mr. Ross, which Mr. Brick took to the World's Fair to get the first prize. With

the settlement of the country and ploughing of the ground, the vast West was pushing the frost line north at the rate of about a township a year. The Peace River country was much more attractive than the Manitoba country twenty or thirty years ago when people said that nothing could be grown there on account of the frosts. He had heard about people near Winnipeg and Manitoba who had had to go out in the night and build bonfires all over their farms simply to neutralise the narrow margin between frost and no frost, and possibly save their crops. It was his belief that the country in Northern British Columbia and Northern Alberta, in the Mackenzie and the Peace River country, offered the finest field for settlement and investment. In travelling through Winnipeg a year ago he came to a little place called Davidson, between Regina and Prince Albert, and found a population of 500. Four years before, a young cousin of his, twenty years of age, went up there to see what he could do. He settled down, and bought a lot of ground round the two or three houses that then constituted Davidson, and after four years his investment had paid 52 per cent. on £20,000. Another field for investment was timber, because Canada produced the finest timber in the world. No area of its size had so much timber as Vancouver Island or such good timber. The climate of the Pacific coast near British Columbia was such, that wood which took a hundred years to grow on any part of the American continent could be grown there in forty years. In Victoria there was only an average of three days' frost in the year. From Winnipeg north there were possibilities of a great waterway, and due east from Fort William and Port Arthur there were possibilities of another great waterway. During the last few weeks of President Roosevelt's administration, representatives from Canada, Mexico, and the United States met in Washington, and all agreed to work together for the economic development of the North American continent, and that fact would have a great deal to do with the development of Western Canada, and in making safe the investments there. There was also a possibility of a waterway by way of Hudson's Bay to England. In fact, everything connected with the future of Canada was not only a source of hope but promised a source of sound safe investment.

Mr. Reginald Enock, F.R.G.S., wished to lay stress on the more Imperial side of the subject. Up to the present the possibility of investment of capital had been considered solely from the point of view of the investor and paying of dividends; but he thought it would be possible to make use in some practical way of millions of square miles of territory for the millions of poor out-of-work people existing in Great Britain to-day. He thought it might be possible by some practical methods to form Imperial companies working on a company basis to take up some of the magnificent resources of Canada and organise them on such a basis that they might be utilised by those members of the British Empire who were at present wandering workless about the streets of great cities, putting them to work and establishing new industrial centres in the Dominion. It seemed to him that the Empire did not appear to belong to the people. For instance, to whom did the enormous territory of Canada belong? Did it belong to the five or six million people who lived there, to the enterprising Americans or Russians who were going there, or to whom? He thought it should be considered to belong to every British citizen, and, therefore, some workable method should be provided whereby every British citizen, head of a family, who required it should be allotted some tangible share of Empire, and should be helped to make use of it. Mr. Enock said he spoke as a traveller and engineer who had spent many years in North and South America, and Canada, and who had given study to the matter of Imperial land development.

Mr. T. R. Clougher thought a debt of gratitude was owing to the Society for the opportunities it gave to people to realise the great resources of the Empire, and as an outsider he wished to bear a tribute to the Society. He thought there was a great and neglected field for British capital in the lack of enterprise in British manufacturers not seeking to do business in Canada. In 1868 there were imported from Great Britain into Canada goods to the value of 35,000,000 dollars, and from the United State manufactured articles to the amount of 22,000,00 dollars. In 1888, when tariff reform was introduce in Canada, the imports from Great Britain had onl grown to 35,000,000 dollars, while the imports fro the United States had grown to 46,000,000 dollar In 1908 the imports from Great Britain had grown t 98,000,000 dollars, while those from the United Stat had increased to 202,000,000 dollars, and this was i spite of the fact that Canada had given to Gre Britain a preferential tariff of 33⅓ per cent. If th manufacturers of Great Britain had not been ente prising enough to occupy the field they were blame for the unemployed in this country and n the Dominion of Canada. Canada was waiting f English goods, preferring them. Canada, in fac wanted English goods so badly that she was pr pared to give 33⅓ per cent. preference, and thought the manufacturers of Great Britain shou realise that Canada offered such a magnifice field for their enterprise. Two years ago speaking to the head of a large manufactur concern, established in 1774, he was told do not know just for the moment what is bei done in Canada, but I will call the gentlem in charge of that Department." That gentlem said, "I am sorry I cannot tell you just h we stand in Canadian matters; many years a we established a branch in Australia and we managing all our Colonial business from our A tralian house." Again, he had heard Canada abu by a gentleman, who said, "We have been striving

do business in Canada for a number of years. We have had a branch house in St. John's, Newfoundland, for nine years."

The CHAIRMAN, in moving a vote of thanks to Mr. Smith for his paper, expressed the hope that the British manufacturer would wake up, and that British trade with Canada under future and more favourable conditions would increase even in a more striking manner than it had increased since Canada gave a preference of $33\frac{1}{3}$ per cent.

Sir WESTBY PERCEVAL, K.C.M.G. (Chairman of the Colonial Section) seconded the vote of thanks, and said the paper fulfilled the object of the Colonial Section, to place reliable information before the public on subjects connected with Greater Britain. He thought Mr. Smith's paper was certainly a very good sample of the useful work done by the Royal Society of Arts. As an Australasian he heartily congratulated Canada, and rejoiced in the progress she had made, and was making, and as a resident in Great Britain, connected with various financial institutions, he was happy to testify that Canada was rapidly gaining the goodwill of investors in this country. Canada was one of the few countries where there was now no income tax, and those who were looking about to find a place where they could evade the super-tax, could not do better than invest their capital in Canada, and allow their dividends to remain in that country for further investment.

Mr. OBED SMITH, in reply, counted it a peculiar honour not only to be able to visit from time to time the meetings of the Section, but to have an opportunity himself of giving expression to his own opinions. He agreed with one of the speakers that the Royal Society of Arts was entitled to the thanks of many for the advantages afforded by its meetings. He thanked Lord Hindlip for occupying the chair, because he knew that his lordship was greatly interested in Canada.

Mr. E. T. Scammell writes :—

Mr. Obed Smith's paper was excellent and opportune. At the same time, I felt, as I listened to it, that what he said for Canada might and should be said for Australia andfor some of our other Oversea States, for in all of these there is a great and increasing need for the investment of British capital.

One of the most striking points of the paper was that in which he showed that Americans are not only taking up great areas of land in the Dominion, but are seeking to get control of Canadian industrials. The list of American manufacturers who have established factories "inside the tariff wall," which is given in the appendix, is worthy of careful note to the manufacturers of the United Kingdom. A similar operation is also going on in Australia, though to a far less degree than in Canada. But it is a significant fact which should not be lost sight of in this country.

Mr. Ben H. Morgan, in the report upon his visit to Australasia and Canada last year, dealt also with this matter, and showed the necessity of the British manufacturer giving some attention to it, if he would keep his hold upon Colonial trade. It is not the question whether our home trade will be interfered with. That is already been done, and the interference will become more extensive as time goes on. The question is whether we are prepared to take our share in the flow of business which these oversea countries of ours are offering, or whether we shall leave it to others. It will be useless for us to mourn the loss when it becomes acute. What is needed is to face the situation now, and for the British manufacturer to get his foot in as soon as possible.

NITROGEN FROM THE AIR.

In connection with Mr. Eyde's paper on this subject, and as supplementing the information it contains, it may be interesting to mention that a paper was read by Professor Bernthsen, before the Congress of Applied Chemistry, on the fixation of atmospheric nitrogen. He stated that "the great importance attaching to the possibility of the fixation of atmospheric nitrogen had, several years ago, been recognised in the Badische Anilin und Soda Fabrik, and after the task of manufacturing indigo on a commercial scale had been brought to a successful conclusion in 1897, special attention was paid to this new problem at the instigation of the managing director, Heinrich von Brunck. As the result of these labours, Otto Schonherr succeeded in 1905, after eight years' work, in discovering and, with the assistance of the engineer, Hessberger, in working out a process of producing an electric arc-flame of a new form, and he was thus enabled to solve the problem in a manner presenting considerable advantages over the method of Birkeland and Eyde. The new process and method was not a mere modification of their process, but differed fundamentally from it. Whereas Birkeland and Eyde caused the electric discharge to burn in a strong magnetic field, and thus spread it out in the shape of a flat more or less circular disc, Schonherr dispensed entirely with magnets and magnetic fields, and produced his arc inside an iron tube of comparatively small diameter, at the same time passing the air through the tube, and thus bringing it into contact with the arc. An agreement had been entered into with the company exploiting the Birkeland and Eyde patents in Norway, and two new companies have been formed, with capitals of 16,000,000 kronen and 18,000,000 kronen respectively, to develop water power, and to erect works for manufacture of nitrates by the new process. Considerable quantities of 'air-saltpetre' would shortly be put on the market, and probably, within a few years, the annual output would reach 100,000 tons."

THE MEXICAN SHRIMP INDUSTRY.

At the village of Pueblo Viego, situated by the Laguna de Pueblo Viejo, about four miles from Tampico, is centered one of the oldest and most interesting of Mexican industries. Here from March to December, the natives gather the "camarones" or shrimp, which abound in the brackish waters of the lake, and in a primitive manner, cook, dry, and prepare them for market. These famous fishing grounds comprise a group of beds of the narrow water passages of the laguna lying between the numerous small islands, and adjacent to the village. They are directly under the Mexican Federal authorities, and contain ninety-two "pesqueros," or trap-like enclosures, that are being worked. These enclosures are V-shaped, and constructed of bamboo poles, well driven in, between which a mat is interwoven, composed of palm leaves, extending from the bottom to the surface of the water, and to within a few feet of the shore at either end. The lake is connected by canal and the Panuco River, with the Gulf of Mexico, from which the salt water is derived, and which the shrimps follow in the course of the tides. They are caught in traps at the outgoing tide, when it is but a simple matter of gathering with a dip net, and conveying them by canoes to the village. On March 1st each year, the names of all applicants for concessions are brought before the collector of the port of Tampico, who directs the lottery held at the Custom-house for the purpose of designating the locations to be given out. The American Vice-Consul at Tampico says that as many numbers as there are applicants, are made out and placed in a revolving receptacle, and the pesqueros allotted the fishermen according to the different numbers selected. Each location is numbered, and the concession is good for one year, or until the next drawing takes place. Thus a man never knows one year just where he will be placed the next. As quickly as possible after gathering the shrimps are carried to the cooking sheds and placed, two bushels at a time, in a large copper kettle, wherein over a primitive Mexican oven, they are boiled in a solution composed of eight parts of water and six parts of salt for a period of fifteen minutes. After removal they are spread over a large cemented enclosure, exposed to the sun, and allowed to dry for half a day. The remaining water in the kettle is boiled away, and the salt recovered for future use. The shrimps are then packed in sacks of four arrovas' (one hundred pounds) capacity, carried by canoe to Tampico and re-shipped to Vera Cruz, where an excellent market is maintained for the fish. There are gathered and prepared for shipment one hundred and fifty tons of shrimps, annually valued at £4,000. Most of them being consumed in the home markets, although an effort is now being made to introduce them into the United States. Canning has been attempted, but with rather indifferent results, and practically the entire production is sold in the dried state.

HOME INDUSTRIES.

The Coal Industry.—The fears expressed when the Coal Miners' (Eight Hours) Bill was being considered by Parliament seem likely to be justified by events. The Act comes into force (outside Northumberland and Durham) on July 1, and in Wales it threatens to bring about a strike, because in Wales the coal masters have notified the termination of the present wages agreement as soon as the Act comes into operation. The Welsh miners refuse to accept any reduction in wages for working a smaller number of hours per day. The Coal Owners' Association contend that the passing of the Eight Hours' Act in itself terminates the existing agreement and brings to an end the present Conciliation Board. Eminent counsel, whose opinion has been taken by the masters, say that this is the correct interpretation of the Act; equally eminent counsel whose opinion has been taken by the men are of the contrary opinion. As regards Yorkshire Derbyshire, and the chief Midland centres, no great friction or disturbance is anticipated, but difficulties in adjusting present arrangements with the requirements of the Act may arise even in districts where the eight hours' system is now in practical operation In not a few districts there are many of the men and boys over sixteen years of age who are underground ten, eleven, and as many as twelve hours out of the twenty-four. Wherever such hours prevail it is obvious that the operation of the Act will effect a great economic change. For the Act is not confined to preventing more than eight hours' work in the mine but prevents any man (with certain exceptions in the case of officials, furnace men, &c.) from remaining in any sense more than eight hours underground in one day. Now eight hours from bank to bank means when deduction is made for the time from proceeding between the bottom of the shaft and the coal face, for meal time and rest times, not more than seven and in some cases not even as much as six hours of actual hewing. Nor is it only the hewers of coal whose hours underground are restricted, but also all the men who work the underground trolleys, and haulage and winding gear. New roads, additional winding machinery and shafts, double shifts, may keep up the output, but only by increasing the cost of production. And if working expenses are increased the price of coal must increase in corresponding degree, and if the price is raised wages must be raised also since miners' wages are regulated by price. There is, indeed, a theory, held by many supporters of the Act that the men will work better in the shorter day and turn out more per hour in eight hours than at present they do in nine or ten hours, but that is not the opinion of those most competent to judge, and there is nothing to show that it is the opinion of the men themselves. It is difficult to avoid the conclusion that, whatever merits the Act may have in other directions, it will increase the cost of coal. Some experts say it will add 5s. a ton to the cost; others are content to put the increase at 2s. a ton; ev

assuming that it is only 1s. the effect may be very serious.

The Effect of Enhanced Coal Prices.—A rise in the cost of output might seriously affect our coal export trade, which year by year has to face more formidable competition, for this increase in the cost of output, due to the Eight Hours Act, affects British coal alone. The cost of production of the coal of our competitors is not affected. Then there are the other great industries whose prosperity is largely dependent on the cost of coal. Take the railway industry. Lord Claud Hamilton speaks with authority on such matters, and he has stated that an increase of 1s. per ton in coal means an increase of £803,000 per annum in the coal bills of the British railway companies. Mr. Bonar Law, an expert in iron, told the House of Commons that an increase of even ninepence per ton on the price of coal would mean an addition of 4s. per ton on the price of steel. It was demonstrated to Mr. Russell Rea's Committee that the proportion which coal bears to the working of steamers ranges from 25 to 30 per cent. in the case of tramps, from 40 to 45 per cent. in the case of mail steamers, and to nearly 50 per cent. in the case of very large and fast steamers. The outlook is disturbing.

Small Holdings.—A good deal of dissatisfaction is expressed at the slow operation of the Small Holdings and Allotments Act of 1908 by those who are eager to see a large increase in *petite culture*, and it is charged against the County Councils that they are lukewarm, or even hostile, in their attitude towards the Act. It is alleged, among other things, that County Councils are charging prohibitive prices for the holdings provided by them, with the object of making the scheme of small holdings a failure. It is true that the price paid for the small holding is often, perhaps generally, excessive, but it does not follow that the Council is to be blamed. In the first place, landowners, as a rule, are not eager to sell, which means that, unless compulsion is to be used, to which the Councils are naturally in many cases averse, a good price must be offered for the land. Then the Board of Agriculture will not approve any scheme which makes it likely that a loss would be incurred in its working; indeed, the Board insists upon a substantial margin being provided for such expenses as management, &c., even as much as from 20 to 30 per cent., insistance that may be explained by the fact that if the Board approves a scheme, and it turns out in the actual working on the wrong side, it is held liable to bear half the annual loss. The terms of rental are too onerous. The rent the tenant is required to pay is based upon a percentage of the cost of the land and its equipment, plus the amount of the annual sinking fund charge, on account of the repayment of the principal money borrowed by the Council. The result is that at the end of the term of years within which the Council are to repay the capital cost of the land, &c., the tenants will have bought from the Council the entire holding. This is surely unfair to the present tenant, who ought not to be asked to pay for the holding itself in addition to a fair rent for it. If the cost of equipping the land with new buildings is added, it is impossible for a County Council, under the Act as it stands, to rent to small holders as cheaply as they can obtain holdings from a private landlord who is willing to arrange small holdings upon his estate, and is content, as many are, with a return of from 2 to 3 per cent.

A Spurt in Shipbuilding.—There is something like a slight spurt in shipbuilding, although the state of the freight market suggests the urgent necessity of restricting the output of new steamers. It seems to be thought by the more enterprising of the current contractors for new steamers that a great expansion of the world's trade is about to be seen, and that it will be to their advantage to anticipate it. It is probable that there will be a great improvement in freights before long, but only if the output of new steamers is restricted. Yet week after week contracts are being concluded for new boats. Some come under the "liner" head; others are to fill up gaps due to navigation, &c., in cargo-carrying fleets; while in some instances the orders have been for tonnage for which there seems no present justification. And now the addition of even a few new steamers means a large quantity of tonnage. In the past boats averaged 1,500 tons, 2,000 tons, or 2,500 tons, and the addition to tonnage was comparatively small, but new steamers run into 5,000, 6,000, 7,000 tons, and a few very large new steamers tell seriously on the position.

Insurance Reform.—The text has now been issued of the Assurance Companies' Bill, promised some time ago by the President of the Board of Tradé, and intended to amend the law of insurance so as to protect the public from "wild cat" schemes. Its main provisions are—(1) The extension to companies carrying on fire and accident insurance business of the laws relating to life assurance companies, subject to appropriate modifications; (2) to bring under the same laws the businesses of bond investment companies, which in return for small subscriptions contract to pay a lump sum at some future date, and which frequently hold out the prospect of a loan in the meantime to be applied to the purchase of a house; and (3) the amendment of the Life Assurance Companies Acts, so as to place foreign companies in the same position as British companies with which they compete, by providing that all companies, wherever registered, shall deposit £20,000 with the Board of Trade. The Bill also simplifies the procedure by which large collecting societies may convert themselves into industrial assurance companies. The new provisions in respect of foreign life offices doing business in this country are founded on the report of the House of Lords' Committee of 1906. Offices

transacting business outside the United Kingdom, whether British or foreign, are required to provide details as to premiums, claims, &c., outside the United Kingdom, as to assets specially deposited under local laws outside the United Kingdom, and as to any separate valuations required under local laws. This provision will enable any intending policy-holder to see what funds are already hypothecated to meet liabilities outside the United Kingdom, and whether these liabilities are estimated on a more stringent basis than the standard one adopted in the return to the Board of Trade. It may be expected that the clauses of the Bill which apply to classes of insurance business other than life, while open to criticism on points of detail, will be generally approved.

OBITUARY.

Harry J. Molloy, M.I.Mech.E., Assoc. M.Inst.C.E. — By the death of Mr. Harry J. Molloy, which occurred from malaria, at Hassan, on March 3rd, the Government of Mysore have lost a valuable servant. Born in 1865, Mr. Molloy entered this service in 1890 as a temporary assistant-engineer on the Bangalore-Hundupur Railway, then in process of construction. Being confirmed in the service in 1895, he worked as assistant-engineer in various departments, including railways, irrigation, bridges, roads, water-supply, &c., until 1903, when he was appointed Officiating Executive Engineer in the Nadur district. This is a malarial region, and here he first contracted the disease to which, after numerous attacks, he succumbed. Mr. Molloy became a Member of the Society of Arts in 1899.

QUESTIONS AND ANSWERS.

NOTICES TO CORRESPONDENTS.

Readers in search of information which cannot be obtained from the usual sources are invited to make their wants known in the *Journal*, in the hope that they may be assisted in their difficulties by their fellow members.

On all communications must be written the name and address of the sender, not necessarily for publication, but as a guarantee of good faith.

Each question or reply should be written on a separate sheet of paper, and should bear such signature of the writer, and such address as he wishes to appear.

Questions which can be answered from the usual books of reference, will not be printed.

QUESTIONS.

Cattle Food from Wood Cellulose.— I understand some French chemists have developed a process for making a cattle food from wood cellulose. Can any one give me particulars?—Dugald Scott.

White Lead and White Lead Paint.— I am in search of information bearing on the manufacture of white lead and white lead paint. I want to know —(1) The most recent practice of the manufacturers in this country; and (2) the best text-book on the subject.—R. M.

Difference between Cupolas and Domes.— What is the essential difference between a cupola and a dome? This sounds a trivial question at first sight, but I cannot obtain a satisfactory answer by consulting "the usual books of reference." My desire for a definition arises from the fact that I have been called to task for referring to the "cupola" of a certain building when it is alleged I should have said "dome;" but, on consulting several architects as to how far we may properly use each term, I have received the most extraordinarily divergent replies. According to the dictionaries the terms are interchangeable, but you surely could not call the dome of St. Paul's a cupola?—St. Pancras.

ANSWERS.

Papin's Digester (see p. 444).—Denis Papin's digester attracted much notice when it was first shown before the Royal Society, and many references to it are to be found in the books of that society. Evelyn, in his "Diary," under date April 12th, 1682, gives a description of a supper attended by Fellows of the Royal Society, at which all the food, "both fish and flesh," was dressed in these digesters, "by which the hardest bones of beefe itself, and mutton, were made as soft as cheese without water or other liquor, and with less than eight ounces of coales, producing an incredible quantity of gravy; and for close of all, a jelly made of the bones of beefe itself, the best for clearness and good relish, and the most delicious that I had ever seen or tasted. We eat pike and other fish bones and all without impediment; but nothing exceeded the pigeons, which tasted just as if bak'd in a pie, all these being stew'd in their own juice, without any addition of water save what swam about the digestor, as *in balneo*; the natural juice of all these provisions acting on the grosser substances, reduced the hardest bones to tenderness." Evelyn concludes: "This philosophical supper caused much mirth amongst us, and exceedingly pleased all the company. I sent a glass of the jelly to my wife, to the reproach of all that the ladies ever made of their best hartshorn." The Hon. Robert Boyle published a later description of the Digester in the Second Continuation of his "Physico-Mechanical Experiments" (1680), in which he translates the name Digester as *Balneum Mariæ*. Papin himself published in 1681, with the permission of the Royal Society, "A new Digester or Engine for softening Bones. By Denys Papin, M.D., Fellow of the Royal Society." In 1687 he published "A Continuation of the New Digester of Bones." The author says that the first improvement he made of the

Digester "was when the King commanded me to make one for his Laboratory.".

The origin of the name *Bain Marie* (Balneum Mariæ) has not been satisfactorily accounted for by Littré. Ducange supposes that it was evolved from a supposed writer of a known alchemical work, whose name was Maria. Whatever may be the truth about this, it seems clear that the name has come down to us from the mediæval alchemical literature. (See Berthelot, "Histoire de l'Alchimie," &c.)—H. B. WHEATLEY.

STAINED GLASS WINDOWS (see p. 597).—It is somewhat difficult to say anything decisive in reply to this question, if only for the reason that before doing so one ought to make quite sure one has in mind the same glass that is referred to. Speaking generally, however, there is a good deal of literary evidence to warrant one in supposing that cobalt was introduced into glass making about the time referred to, and that as it was probably used in an impure state in the first instance, such a colour would be made with it. Although Bruchmüller (*Der Kobaltbergrau und die Blaufarbenwerke in Sachsen*) considers that the use of cobalt in the arts dates so far back as to be lost in obscurity, there seems very little doubt that the peculiar properties of the cobalt ores of Saxony were only recognised about the end of the fifteenth century. Up to that time they had been regarded as useless: the very name cobalt, in fact, emphasises this, signifying, as it does, an evil spirit, and being derived from the fact that the old miners when they came across cobalt ores in searching for iron considered they had been enchanted and made useless by the evil spirits of the mine. Many writers have tried to prove that the pigmentary properties of the cobalt compounds were known to the Egyptians, but so far as I am aware there is no practical, as distinguished from literary, evidence in support of this: that is to say (although people have juggled with the words "lapphre" and "sapphire" in an attempt to prove that their use by Theopilus and earlier writers must have signified cobalt) no one has ever found cobalt on chemical analysis of any specimen of glass or pottery earlier than the fifteenth century—no one, that is, that I have been able to discover. I would not like to make this statement positively, because such records have a way of getting into the most unlikely places and escaping one's notice. We do know for certain, however, that the cobalt ores in Saxony began to be explored at the close of the fifteenth century, and that Schurer commenced to manufacture smalt about 1520 in Bohemia, whence its use spread to Italy and Holland, and became the subject of an English patent in the reign of James I. This, then, would account for its use in connection with stained glass at this time and not before, presuming that the colour of the particular glass referred to is due to cobalt. But one must bear in mind that the introduction of a fresh tint in glass is not necessarily due to the use of a new colouring agent—the composition of the white glass in which any colouring oxide is dissolved, has a considerable influence on the resulting colour, and it was at the period referred to that the use of soda in glass making, in place of potash, began to be introduced, and the composition of window glass gradually reverted from the highly basic material of the Middle Ages back to the soda-lime glass used by the Romans, and forgotten for a thousand years. One would expect as a result of this to find new tints appearing in the windows, but of course this is all conjecture—the only practical way of settling the matter would be to make careful complete analyses of glasses of different periods, but this, being a lengthy and costly business, nobody cares to do.—N. H.

NOTES ON BOOKS.

THE ARCHITECTURE OF THE RENAISSANCE IN ITALY. By William J. Anderson, A.R.I.B.A. London: B. T. Batsford. 12s. 6d. net.

When this book was first published in 1896, it at once took its place as the standard work on the subject with which it dealt. A second edition was called for in 1898, a third shortly afterwards, and now a fourth and enlarged edition has been prepared by Mr. Arthur Stratton, Lecturer on Architecture at King's College, London. The success of the book may be traced to three causes: the excellence of the text, for the late Mr. Anderson was a master of his subject, and he wrote with a cultured and scholarly pen; the excellence of the illustrations, to which many valuable collotypes have been added in the present edition; and the fact that it supplied the student for the first time at moderate cost with a clear and comprehensive view of the whole course of the Renaissance in Italian architecture. The book is too well known to call for a descriptive notice here. Suffice it to say that the task of revising Mr. Anderson's work could not have been entrusted to a more competent editor than Mr. Stratton: while he has been well advised not to alter or increase the subject matter to any large extent, he has added many photographs and measured drawings which have been selected with the greatest care and are admirably reproduced by Mr. Batsford.

GENERAL NOTES.

WHITE PHOSPHORUS IN MATCHES.—In the annual report of the Chief Inspector of Factories and Workshops (Mr. Arthur Whitelegge), for the year 1908, which has just been issued, attention is drawn to the fact that the White Phosphorus Matches Prohibition Act, 1908, will come into force on January 1st next. After that date white phosphorus matches may not be made and imported, and after January 1st, 1911, may not be offered or exposed

or held for sale. The Board of Trade are empowered to grant licenses for the use of any process, patented before the date of the Act, for making matches (not intended to strike only on a specially prepared surface) without the use of phosphorus, and to fix the terms. Meanwhile all the match factories in the United Kingdom, with one notable exception, remained free from any case of necrosis, as in the three previous years; but in that one factory a further case occurred in 1908, and two other attacks have been reported in the first quarter of 1909. The disuse of white phosphorus in this industry will render obsolete the special rules established in 1899. . . . . It may be that for a time cases of necrosis will still occur among persons who in the past have been exposed to phosphorus, but the exposure will cease with 1909, and in some at least of the works, including that in which all the recent cases have occurred, arrangements are being made to anticipate the appointed date.

BRITISH TRADE IN KERMAN, SOUTH PERSIA.—A private correspondent writing under date of 1st April from Kerman in the British sphere of Central Persia, states that that city is just taking the place of Yezd as the chief distributing centre of the country. A sample room containing specimens of the British and Indian goods most in demand in that part of Persia and capable of being supplied through Bunder Abbas, has been started by the British Consul and placed in charge of a British merchant. The Consul, Major Ducat, is very anxious to make English traders aware what an exceptional opportunity there is for capturing a profitable market which otherwise must fall into the hands of the Russians. The chief desideratum is the improvement of the road communication and the establishment of a regular and reliable transport service between Kerman and the Indian Ocean at Bunder Abbas. In the meantime the Russians are pouring in their goods from the north *viâ* Meshed. Two New York firms have established American agents in Kerman, a third has a Europeanised Armenian acting for them in the surrounding districts, and a fourth firm talk of establishing a regular agent in the city. The chief article of export is of course the far-famed Persian carpets, but there are mineral and other resources waiting to be exploited if the road difficulties are once effectually grappled with. So far as the carpet trade is concerned the new agents are already cutting out the Tabriz Turk buyers.

MEETINGS FOR THE ENSUING WEEK.

TUESDAY, JUNE 15...Faraday Society, in the Library of the Institution of Electrical Engineers, 92, Victoria-street, S.W., 8 p.m. 1. Mr. E. R. Taylor, "The National and International Conservation of Water for Power." 2. Mr. W. Fielding, "The Formation of Silicon Sulphide in the Desulphurisation of Iron." 3. Mr. Ch. A. Keller, "A Contribution to the Study of Electric Furnaces as Applied to the Manufacture of Iron and Steel." 4. Mr. Gustave Gin, "Automatically Circulating Furnaces of the Gin Type for the Electrical Production of Steel."

Asiatic, 22, Albemarle-street, W., 4 p.m. Dr. E. Denison Ross, "A Unique Arabic MS. containing the History of Gujarat under Muhammadan Rule down to the Time of Akbar."

Statistical, 9, Adelphi-terrace, W.C., 4½ p.m. Annual General Meeting. Mr. G. Paish, "Great Britain's Capital Investments in Foreign Lands."

WEDNESDAY, JUNE 16...National Indian Association (at the HOUSE OF THE ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.), 4½ p.m. Mr. R. F. Chisholm, "The Taj Mahal, Agra."

Meteorological, 70, Victoria-street, S.W., 4½ p.m. 1. Mr. R. C. Mossman, "The Interdiurnal Variability of Temperature in Antarctic and Sub-antarctic Regions." 2. Dr. W. Schmidt and Mr. E. Gold, "Testing of Registering Balloon Apparatus at Low Temperatures." 3. Mr. L. C. W. Bonacina, "A Plea for the Use of Freely-Exposed Thermometers in Addition to Sheltered Ones."

Geological, Burlington-house, W., 8 p.m. 1. Mr. J. A. Douglas, "The Carboniferous Limestone of County Clare." 2. Dr. J. E. Marr and G. W. Fearnsides, "The Howgill Fells and their Topography." 3. Mr. L. Glauert, "A New Species of *Sthenurus*." 4. Mr. D. S. Watson, (*a*) "Some Reptilian Remains from the Trias of Lossiemouth." (*b*) "Some Reptilian Tracks from the Trias of Runcorn (Cheshire)." (*c*) "The Anatomy of *Lepidophloios laricinus*, Sternb."

Microscopical, 20, Hanover-square, W., 8 p.m. Exhibition by Dr. J. A. Brayton Hicks of the Better-known Tropical Parasites.

THURSDAY, JUNE 17...Linnean, Burlington-house, W., 8 p.m. 1. Mr. J. G. O. Tepper, "The Growth of a Species of Battarea." 2. Sir John Murray, "The Deposits in the Indian Ocean." 3. Mr. L. A. Borradaile, "The 'Sealark' Perseidea, Steoropidea, and Reptantia." 4. Mr. F. A. Potts, "The 'Sealark' Polychæta." (Part II.) 5. Mr. T. Bainbrigge Fletcher, "The 'Sealark' Lepidoptera." 6. Dr. H. Christ, "New Species of Malesian and Philippine Forns." 7. Messrs. T. A. Sprague and J. Hutchinson, "The African Species of Triumfetta. Linn." 8. Mr. A. W. Hill, "The Acaulescent Species of Malvastrum, A. Gray." Exhibition by Mr. Clement Reid of Plants in Britain introduced by the Romans.

Chemical, Burlington-house, 8½ p.m. 1. Mr. S. P. U. Pickering, "The Carbonate of Copper and the Cupricarbonates." 2. Mr. F. L. Pyman, "Isoquinoline Derivatives. Part I. Oxidation of Laudanosine." 3. Messrs. J. T. Hewitt and W. Thomas, "The Colour and Constitution of Azo-Compounds." 4. Messrs. H. J. H. Fenton and W. A. R. Wilks, "Isoiminazolone." 5. Messrs. H. J. H. Fenton and F. Robinson, "Homologues of Furfural." 6. Messrs. T. M. Lowry and C. H. Desch, "Studies of Dynamic Isomerism. Part IX. The Relationship between Absorption Spectra and Isomeric Change. Absorption Spectra of Sulphonic Derivatives of Camphor." 7. Mr. B. Flürscheim, "The Relation between the Strength of Acids and Bases and Quantitative Distribution of Affinity in the Molecule." Part II. 8. Mr. H. D. Dakin, "The Oxidation of Hydroxy-Derivatives of Benzaldehyde and Acetophenone." 9. Messrs E. de B. Barnett and S. Smiles, "The Intramolecular Rearrangement of Diphenylamine *ortho* Sulphoxides."

FRIDAY, JUNE 18...Royal Institution, Albemarle-street, W., 9 p.m. Mr. A. Henry Savage Landor, "A Recent Visit to the Panama Canal."

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FRIDAY, JUNE 18, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Fifty-fifth Annual General Meeting for the purpose of receiving the Council's Report and Treasurers' Statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held in accordance with the By-laws on Wednesday, 30th June, at 4 p.m.

(By Order of the Council),
HENRY TRUEMAN WOOD,
Secretary.

ALBERT MEDAL.

The Council of the Society, with the approval of His Royal Highness the President, have awarded the Albert Medal of the Society for the current year to Sir Andrew Noble, K.C.B., D.Sc., D.C.L., F.R.S., "in recognition of his long-continued and valuable researches into the nature and action of explosives, which have resulted in the great development and improvement of modern ordnance."

MEDALS FOR PAPERS.

The Council have awarded the Society's Silver Medal to the following readers of Papers during the Session 1908-9 :—

At the Ordinary Meetings :—

To Mr. G. ALBERT SMITH, for his paper on "Kinematography in Natural Colours."

To Mr. HENRY C. BREWER, for his paper on "Gothic Art in Spain."

To Monsieur YVES GUYOT, for his paper on "The Commercial Relations of France and Great Britain."

To Mr. GEORGE HUBBARD, for his paper on "Dew-ponds."

To Mr. WALTER ROSENHAIN, for his paper on "The Application of the Microscope to the Study of Metals."

To Mr. GABRIEL GORDON CLEATHER, for his paper on "The Musical Aspect of Drums."

To Mr. C. REGINALD ENOCK, for his paper on "The Resources of the Peruvian Andes and the Amazon."

To Mr. PERCY A. WELLS, for his paper on "English Furniture Design and Construction."

To Mr. ARTHUR JOHN BARRY, for his paper on "Railway Development in China."

To Herr SAM EYDE, for his paper on "The Manufacture of Nitrates from the Atmosphere by the Electric Arc."

In the Indian Section :—

To Mr. DOUGLAS DEWAR, for his paper on "The Birds of India."

To Mr. ARTHUR ANTHONY MACDONELL (Boden Professor of Sanskrit, Oxford), for his paper on "The Buddhist and Hindu Architecture of India.'

To Mr. SELWYN HOWE FREMANTLE, for his paper on "The Problem of Indian Labour Supply."

To Mr. KRISHNA GOVINDA GUPTA (Member of the Council of India), for his paper on "Some Phases of Hinduism."

To Mr. CECIL L. BURNS (Principal, Bombay School of Art), for his paper on "The Functions of Schools of Art in India."

In the Colonial Section .—

To the HON. CHARLES GIDEON MURRAY, for his paper on "The Road to South African Union."

Of recent years it has been the practice that no medals should be awarded to readers of papers who had previously received medals from the Society. Acting on this rule the Council were precluded from considering the following papers :—In the Ordinary Meetings the papers by Sir W. Martin Conway, on "The Goldfields of Eastern Peru and Bolivia," and by Mr. Archibald R. Colquhoun, on "Bosnia and Herzegovina ; " in the Colonial

Section, the papers by Mr. Albert E. Humphries, on "The Production of Wheat in the British Empire," and by Mr. John Ferguson, C.M.G., on "Ceylon: its Industries and Material Progress."

The Council, however, desire to express their high appreciation of these papers by thanking their authors for them.

The brilliant lecture delivered, under the Aldred Trust, by Professor Dendy, was not considered to be eligible for a Medal, though it occupied one of the Ordinary Meetings.

EXAMINATIONS.

The results of the Advanced Examinations (Stage III.) have been published, and copies have been sent to all Centres for distribution to Candidates.

The results of the Intermediate Examinations (Stage II.) will be published during July, and those of the Elementary (Stage I.) early in August.

CONVERSAZIONE.

The Society's Conversazione will be held, by permission of the Trustees of the British Museum, in the galleries of the Natural History Museum, South Kensington, on Tuesday evening, June 29th, from 9 p.m. to 12.

The Reception, by Sir William H. White, K.C B., F.R.S., Chairman, and the other Members of the Council, will be held in the Central Hall from 9 to 10 p.m.

A Selection of Music will be performed by the Band of H.M. Royal Engineers, in the Central Hall, commencing at 9 o'clock.

An Instrumental Concert by the "Red Band," under the direction of Mr. Thomas Batty, will be given in the Fish Gallery from 9.15 till 10.15 p.m., and from 10.30 till 11.30 p.m.

A Gramophone and Auxetophone Concert, under the direction of the Gramophone Company, will be given in the Shell Gallery at intervals from 9.15 p.m.

The following portions of the Museum will be open:—

The Central Hall, containing cases of specimens illustrating Mimicry; adaptation of colour to surrounding conditions; protective resemblance, &c.; also specimens illustrating the food of Fishes, and the life-history of the Eel (East of staircase).

The North Hall, containing the collection of Domesticated Animals.

The Bird Gallery, containing groups of British Birds and Nests; and in the Pavilion, at the West end, an exhibition of the Land and Fresh-water Vertebrate Animals of the British Isles.

The Fish Gallery, containing the Great Basking Shark, the grotesque deep-sea fishes (case 44), the Tunny (case 38), the Tarpon and Angler-fish (case 27), the Lemon-sole (case 30), &c.

The Shell Gallery, including a life-size model of a Giant Squid (Newfoundland), and of a giant Octopus (California).

The East and West Corridors on the First Floor, containing the Okapi, African Antelopes, and Giraffes.

Light Refreshments will be supplied at Buffets in the North and South Corridors on the First Floor of the Museum.

Visitors travelling by District Railway (or other underground railways in connection therewith) will be allowed free use of the Company's Subway, which leads from the South Kensington Station direct into the grounds of the Museum.

Each member is entitled to a card for himself (which will not be transferable) and a card for a lady. These tickets have now been issued. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by members, at the price of 5s. each, if purchased before the day of the Conversazione. On that date the price will be 7s. 6d.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary at the offices of the Society, John-street, Adelphi, W.C. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman, and must be signed by the member applying for it.

Tickets will only be supplied to non-members of the Society on presentation of a letter of introduction from a member.

It will greatly facilitate the arrangements if members requiring additional tickets will apply for them at as early a date as convenient.

The Council reserve the right of stopping the sale of tickets or of raising the price, if it is found necessary, in order to restrict the number of visitors within reasonable limits.

Further particulars as to the Musical and other arrangements will be given in the Programmes which will be distributed on the evening of the Conversazione.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

Thursday afternoon, May 27th; PROFESSOR SIR HUBERT VON HERKOMER, C.V.O., D.C.L., R.A., in the chair.

The CHAIRMAN said he had had some information from independent sources as to the good work Mr. Burns had done in Bombay, and was especially interested in him because he was one of his earliest students at Bushey. He had heard that when Mr. Burns was appointed in 1899 he found the School of Art not in the best of conditions, but owing to his energy and skill it was now one of the most successful in India, with departments for textiles, pottery, and design, and workshops for plastic and metal working. He had done excellent service in training drawing masters and revising the system of teaching entirely on sound principles, and the school was popular and efficient.

The paper read was—

THE FUNCTIONS OF SCHOOLS OF ART IN INDIA.

By CECIL L. BURNS,
Principal of the Bombay School of Art.

In considering the functions of schools of art in India, and offering suggestions regarding the broad lines upon which, in my opinion, they can successfully cope with the peculiar problems they are intended to solve, I must premise my remarks by saying that my practical experience has been confined to the work performed by the School of Art in Bombay city and Western India.

Of course, like other officers whose time and duties are devoted to assisting the progress of the country in a special direction, I have made it my business to see as far as possible the work carried on in other schools of art, and have studied the reports, dealing with my subject, issued by the Governments of other provinces. The knowledge I have thus gained, leads me to believe that although slight variations may occur in the local conditions elsewhere than in Bombay and Western India, the problems with which I shall deal this afternoon are fairly general throughout India.

To discuss the whole of the functions of the schools of art would, I fear, take up more time than I have at my disposal this afternoon. I, therefore, propose to limit the scope of my remarks to the relation they have to, and are capable of exercising upon, the applied arts of the country. Although this limitation should not entirely exclude some reference to the study of architecture, sculpture and painting, pursued in the schools, for these arts are but the development and higher expression of kindred crafts, it is unfortunately true that in India, as in Europe, the teaching of those branches of art has become separated in modern practice from the teaching of the crafts. I shall, therefore, have to leave what are known as the Fine Arts unconsidered except where they directly relate to the industries of India.

The limitation I propose, however, coincides with the declared purpose of Government in founding the schools of art, which was to preserve from decay and to improve the crafts of the country. In order to give you some idea of the nature of the task the schools have been called upon to perform, and the peculiar difficulties of that task, it will be necessary for me to notice briefly the revolutionary changes in the conditions under which the crafts of India are now carried on as compared with those prevailing up to the year 1857, when the schools of art were first instituted. These changed conditions appear to me to lie at the very root of the admitted decadence of the ancient crafts of India, and so far from being ignored must form the basis of any attempts to revive their former prosperity.

THE FORMER ISOLATION OE INDIA.

Up to the year 1850, India, from an artistic stand-point, was almost entirely isolated from the rest of the world. In fact, she was more isolated during the eighteenth and early part of the nineteenth centuries than was the case during the sixteenth and seventeenth centuries, when the Moghul emperors were carrying out their great building schemes. We know that for the elaborate structures erected by Akbar, Jehangir, and Shan Jehan, huge armies, which included foreign, as well as native workmen, were employed, while the splendour of the courts of those emperors attracted an almost equal number of other craftsmen, chiefly goldsmiths, carvers, and brocade weavers. The foreign craftsmen undoubtedly exercised a very considerable influence upon the style of the buildings erected at that period, especially with regard to their decorations, and it was the introduction of new ideas by these foreigners, allied to the special aptitude for particular craft work on the part of the Indian workmen, due to the caste system, which resulted in

producing the best schools of art India has yet seen, and the golden age of Indian artistic work.

The wars and resultant social disturbance accompanying the decline of the Moghul rule changed everything. The great works of a former age were stopped, and the army of foreign and native craftsmen was disbanded. A certain number of native artisans were doubtless retained about the decadent Court at Delhi, or took service with the chiefs and rajas who ruled as independent sovereigns the former Moghul provinces, but as warfare was almost continuous, it is certain that the encouragement given to these craftsmen was spasmodic, while the foreigners either returned to their homes or dying were not replaced.

From the East India Company the indigenous artistic craftsmen received even less support than from the rulers who immediately preceded it. The early exports from India to Europe were mainly of raw or partially worked products, and when the Company ceased to be only traders, and acquired territory, both directors and officers were too busy with the task of consolidating their rule within the recently acquired provinces and in repelling attacks from their neighbours, to afford the time to foster and encourage the arts of the country.

The artistic craftsmen employed by the princes whose kingdoms were occupied by the East India Company in the later end of the eighteenth and early part of the nineteenth centuries, again either migrated to the Courts of those native chiefs who still ruled their own kingdoms, or they established themselves in small towns and villages, and had to depend for support upon the uncertain patronage of the local public.

The Freedom of the Indian Craftsmen from Foreign Competition.

The isolation of these towns, not only from Europe, but from the rest of India, gave the workers in them a practical monopoly in their local markets. The artistic work was in many instances carried on by the descendants of the men who had helped to build, or decorate, the palaces and mosques of the Moghuls, but the tradition of that great period had died out. Methods of work had become purely rule-of-thumb ones, and although these were often full of ingenuity, and marvels of patient industry, the processes the workmen employed were devoid of that basis of scientific knowledge which alone could lead to improvement. The patterns they used, gradually became few in number, were traditional in character, and were suited only to meet the local requirements or the tastes of a small section of the community.

Being without literary education, and therefore ignorant of what the rest of the world had done or was doing, being cut off from contact with workmen engaged in similar crafts in other parts of India, and being without ambition, the workmen stagnated. Methods remained unimproved, and from much copying their designs became lifeless, while the craftsmen, from never attempting to devise new patterns, lost whatever power of original thinking they may have formerly possessed.

They were doubtless poor, according to European standards, but as they were free from all outside competition, they were well able to live by their work. Their few and simple implements were admirably adapted to the isolated condition in which both craftsman and client lived. This simplicity enabled most of the craftsmen to carry their trades upon their backs. There is, for instance, something delightfully artless in the methods of the district potter, who is still to be met with in country districts, carrying his light wooden wheel upon his back. When he arrives at a village, he sets himself down on the outskirts, weights his wheel with the same local clay he has previously dug, in an adjacent field, for his pottery, sets it turning upon an iron spindle which he has carried with him in his belt, and which he fixes vertically in the ground. He then proceeds to turn out pots for the village. These he bakes in a rough earthen kiln, and when they are fired, and disposed of, the potter chips the dried earth from off his wheel, restores the spindle to his belt, and with the wheel on his back tramps off to repeat the operation at the next village.

The pottery thus made is cheap, and serves its purpose, and as the forms are those naturally taken by clay thrown upon a potter's wheel, they are often beautiful, while as no attempt is made to give finish to the surface after they have dried, they retain the charm inseparable from the impress of the human hand. Such a system, however, is unlikely to lead to improved methods of work, or to the eventual production of wares comparable to those issuing from the kilns of Meissen, Sèvres, or Staffordshire

Most of the other handicraft work of India formerly possessed a distinctive character, due

to the isolation of the workmen, but from the internal causes before specified it deteriorated in quality, though despite its failings it still provided a living to the craftsmen.

Attempts to Revive the Ancient Crafts by Establishing Art Schools.

While this process of decadence had been going on, Europeans of cultivated taste and learning, most of whom belonged to one or other of the services of the East India Company, had studied assiduously the ancient religions, the archæology, and the art of the country. The beauty and distinctive character of the buildings and craft-work of a former period had aroused their enthusiasm. Comparison between the old work and the modern revealed the deterioration that had taken place in the latter, and archæologists began to advocate steps to arrest this decay.

At the same time, practical Indian business men who had had the opportunity of studying the superior mechanical quality of the craft-work of Europe, and its organised methods of production and distribution, and of comparing it with the rougher work of the isolated craftsmen of India, recognised the necessity of adopting improved methods on the part of the latter, if they were to retain their position in their own markets, which were beginning to be invaded from the West.

About the middle of the last century there was thus a consensus of opinion in favour of some steps being taken toward the improvement of Indian craft-work, and the movement in England at that time, which resulted in the establishment of schools of art throughout this country, provided the opportunity for all those interested in the desired revival, to press upon Government the establishment of similar schools in India. Thanks to the persuasive writing of eminent servants of the Company and the munificent initiative of the first Sir Jamsetjee Jeejeebhai, the distinctly chilly attitude of the Court of Directors was at length transformed into one of tepid acquiescence, and schools of art on a very modest scale were started in Madras and Bombay.

A fundamental difference regarding their functions existed in the minds of the two sections of Indian opinion whose combined efforts brought about the establishment of the schools of art. Those whom for want of a better term I may call the archæologists pinned their faith in a possible revival of the crafts upon a strict adherence to the ancient traditional types of design and practice, and those whom I will style the practical men based their hopes of improvement upon the introduction of European methods while leaving the question of design unconsidered. There was one element necessary to the realisation of the aims of both advocates of reforms, which neither seems to have completely recognised. This was that success depended upon the continued isolation of India from competition with the art-workers of Europe. To accomplish a revival of Indian art upon purely traditional lines, in the absence of a compelling movement from within the country, which did not exist, the art of the West had to be excluded. Isolation and time were also required to improve the methods of the Indian craftsmen, if they were to be in a position to compete on equal terms with the better equipped and organised workmen of the West.

Failure due to Changed Conditions.

The opening of the Suez Canal was the death-blow to the realisation of the hopes of both sections. India from an artistic point of view quickly became and has since remained a suburb of Paris and London, as she is from an industrial point of view the suburb of Manchester and Birmingham.

Forms of art previously unknown have by means of imported reproductions and original works become familiar to the people of India, while the local markets have been invaded by artistic craft-work made by the organised workshops of Europe, before the Indian craftsmen have had time to improve their methods.

The great increase of wealth due to the extension of Indian trade has also brought about a change in the style of living among the wealthy classes in India, many of whose individual members have been educated in this country and still more of whom have visited England. These have become familiar with and have adopted Western ways and have furnished their houses in European style. Every season also sees in England a greater number of the members of the families of the ruling princes of India, and their capture is an object of ambition by the tradesmen of the metropolis, whose goods are found in every palace in India. As a typical instance of the extent to which this change of taste has grown, I may mention that out of over two hundred presents given upon the occasion of a recent wedding of a well-to-do Indian gentleman and lady, I could find only sixteen that

were of Indian origin, the remainder being of European manufacture or copied from European patterns by Indian craftsmen.

It is also a curious instance of the effect politics may have upon art, that settled government under British rule has had a distinct influence upon the style of the jewellery and personal ornaments worn in India at the present day as compared with those of fifty or even thirty years ago. In the old days, articles of gold and silver were regarded chiefly in the light of portable property, easily hidden, and reconvertible into money. They were, therefore, valued more on account of the weight of precious metal they contained than for the beauty and elaborate nature of their workmanship. The massive proportions and primitive character of the old Indian jewellery and metal work was due to this consideration. Of late years, owing to the greater security of personal property a stable form of government has afforded, the old reasons for weighty articles of personal adornment have ceased, and the lighter and more delicate styles of workmanship of Europe have begun to supersede the ancient types. Imported articles fill the shops in the bazaars of the large cities, and are pushing their way into the country towns, where they are copied by the native artisans.

Another result of settled government tending toward the introduction of alien ideas is the alteration that has taken place in the style of the buildings being erected throughout the country.

Coincident with and as a result of increased wealth extraordinary activity has occurred in the building trades in India. Great improvement schemes are in progress in Bombay which involve the rebuilding of large sections of the city, and the occupation of every vacant plot by new structures. During the short period of nine years I have seen the business quarter of the city almost transformed and commercial firms rehoused in palatial offices, fitted and appointed in a manner that would do credit to any city in Europe. Large and costly public buildings have already been put up or are in course of erection, which, so far as their dimensions are concerned, have scarcely been seen in India before, and the same activity is to be witnessed in almost every considerable town in the country.

The style of these buildings, however, is rarely, if ever, purely Indian or even Eastern in character, but in the majority of instances is either European or of some composite style of architecture. The arguments for and against the adoption of European styles in modern Indian buildings were ably stated in a paper read before this Society by Mr. T. R. Smith in 1873, and the question has since been fully considered in connection with the erection of the Queen Victoria Memorial building in Calcutta. It is too large a subject to discuss this evening, but the decision to adopt European styles in Government and other public buildings is one decidedly germane to our subject. As all the decorative arts have originated from and are dependent upon the style of the architecture they are intended to enrich, the decision referred to must exercise a powerful influence upon the practice in all the crafts allied to the building trade, and through them upon the teaching in the schools of art.

Thus we find at the present day that India has ceased to be isolated, and that potent forces both within and without have been and are at work to modify the indigenous character of her art by that of Europe. Her craftsmen have, without preparation, found themselves confronted by the keen competition of the rest of the world, in place of the comparative monopoly they formerly enjoyed in their own local markets under the fostering care of Rajas and religious communities. They have been called upon to supply patrons with articles of alien origin and use in place of those of traditional types, and to provide the decorative details to buildings concerning the architectural styles of which they are entirely ignorant as regards their origin, growth, or the principles upon which those styles are based or have been developed.

How have the Indian craftsmen met the changed conditions? Their ancient art had decayed from internal causes before the European incursion made the situation as acute as it has since become. The invasion caught them before they had been equipped to meet it, and they have been forced to struggle against extinction by the cheapening of their handiwork until it has lost nearly every characteristic which made it valuable. In the interior of the country, where the pressure is not so acutely felt, the artistic craftsmen painfully compete with their rivals of the West by their superior knowledge of purely local requirements and by the cheapness of their mode of living. In the larger centres they attempt to meet the demand for articles of European origin, by copying the patterns to be

found in the trade catalogues of English and German firms. Such catalogues are certainly not the kind of text-books we would recommend a student to consult, and the result is that the Indian craftsmen copy, as a rule, the ordinary commercial patterns, instead of the most artistic Europe has produced. I well recollect, soon after landing in India, asking the master in the wrought-iron class in the Bombay School of Art workshops, to furnish me with a design for a standard lamp. The man was a very capable smith—though rather too much addicted to riveting in place of welding his ironwork—and a man of fair intelligence. He promptly produced from a cupboard an ancient and well-thumbed copy of a catalogue issued by a North of England firm of cast-iron railing manufacturers in the year 1867, when the Applied Arts were certainly not at their best in England, and it was from this treasure-house of artistic suggestion that he proposed seeking inspiration for his design. Outside his workshop was growing a plant, whose stems and foliage were so admirably adapted to treatment in metal, that I was at first under the impression that it had been purposely planted with that object, but when I drew his attention to its suitability for the proposed design, he regarded the suggestion as some form of subtle pleasantry on the part of the "Sahib." It took a considerable time to persuade him that a natural form could in any way be utilised for the purposes of his craft, and still longer to convince him that his pattern-book was more valuable as fuel than as a work of reference—though it is scarcely necessary to add that he read no more in that book during that or any subsequent day.

I may instance Indian silverwork, an industry both widespread and full of distinctive character in the past, as one that has deteriorated seriously from internal causes and outside influences. Even in the design and workmanship of articles of traditional shape and use, it is almost impossible now to obtain examples of pure design and good proportion. Much of this want of harmony is due to the fact that in the silversmiths' workshops in many of the large cities, craftsmen from different parts of India and Burma are employed and work side by side. Each of these workmen knows a few traditional designs which he has inherited from his father, but none of them have ever been trained to understand the principles upon which all design is based. When cut off from the safe anchorage of tradition these craftsmen are completely adrift, but none are adverse to borrowing the designs of his neighbour. The only guidance and superintendence the workmen receive is from the owner of the shop, who is not an artist but a tradesman. It is not surprising, therefore, that in the case of indigenous articles, the decorative details have become very mixed; while when an article of alien origin is being made a single specimen often includes a shape copied from a British or German trade catalogue, embellished with mouldings taken from half a dozen different sources, stands upon feet of French design, is encircled by a Poona hunting scene or by Burmese gods, and if it be a tea-pot will have an old English handle and an elephant's trunk for a spout—and the unfortunate thing about the whole is that the designer and makers of this anachronism are not only absolutely unconscious of its failings, but are both proud and pleased with their ingenuity in getting so much variety into a single work. Whatever objections may be urged against the good taste of the products of the organised factories of Birmingham and Sheffield, fault cannot be found with them on the score of their mechanical finish or their efficiency in serving the purpose for which they are intended, while the British hall-mark upon them is a guarantee that the silver used is of a trustworthy standard of purity. So much, I regret to say, cannot be said for the majority of the Indian silver articles of a similar type. There is a roughness about the edges, a tendency to stand upon three legs, a "wobbly" action about the hinges, which evince an almost indecent alacrity in parting from the lid or body of the article, and a proneness to pour from anywhere except the spouts of their teapots, that the owner of many an Indian silver tea set must have noticed as falling below the standard in these respects of the British-made article. As regards the quality of the silver used I fear that in many instances the metal is more remarkable for the skill with which the greatest amount of the baser metals has been added to the alloy without affecting its colour, than as an ideal standard of purity. Much of the deterioration of Indian silverwork is also undoubtedly due to the determination of the "globe-trotter" to get something he considers characteristically Indian. He knows that Indian work is supposed to be elaborate, and he, therefore, requires the surface of any article he purchases to be covered with ornament, but he refuses to pay the price at which the elaborately finished

hand-work of the past was produced. He gets, therefore, a roughly made article, covered with hastily executed ornament in a metal that looks like silver, but which no one will venture to submit to the test of Goldsmiths' Hall on his return to England.

The European visitor to India has thus been the means of encouraging the faults most noticeable in the Indian silversmiths, namely, their want of care and accuracy in finishing their work, and it is in consequence of these faults that the reputation of Indian silverwork has been brought to its present low point in the estimation of connoisseurs and collectors in Europe.

In most of the other artistic crafts of India the same struggle is to be seen of imperfectly educated and inadequately-equipped workmen competing against the highly-organised and educated craftsmen of the West in their own markets, and driven from all those foreign ones which they formerly supplied, not in consequence of the action of hostile tariffs, but by reason of their lack of capacity to adapt themselves to altered demands and changed conditions. I may instance the case of the weavers in the small town of Thana, near Bombay. Within living memory there were 6,000 of these men employed in the production of finely-woven fabrics for the English market. The trade has been completely lost in consequence of a change of fashion in England, and the incapacity of the craftsmen to design any patterns except the few traditional ones they had inherited, and the number of weavers in the town is now reduced to five or six, who can scarcely exist by supplying a limited local demand. The same want of knowledge of design prevents the patient and skilful brocade workers of Western and Central India from reaping the advantage their cheap living should give them over the English and French hand weavers of costly brocades, for which there is now a steady demand in Europe and America. They also have consequently to be content with a bare existence obtained from a small local demand, while the shops in the European quarters and the bazaars in the native cities are stocked with fabrics of European design or of excellent reproductions of Indian patterns made in England, France and Germany.

A striking instance of the extinction of a budding artistic industry due entirely to the want of scientific training occurred in the case of the pottery attached to the Bombay School of Art. Many people will remember this pottery, which was carried on commercially by the late Mr. Terry, who for some time was the Principal of this School of Art in its early days. The style of the pots produced was that of the old Sind tile work, and potters from Multan were brought down to do the work. This ware had a considerable vogue in England, as some of the pieces were beautiful both in shape and colour, but as the body was extremely porous and the glaze soft and irregular, the percentage of breakages in transit was, despite careful packing, extremely large. Another drawback due to these faults was that the jars refused to hold water. This latter failing led to rather unfortunate results occasionally, and I well remember some time before I went to India witnessing the disastrous effect not only upon a very fine specimen of this ware, but incidentally upon a grand piano and its silk cover, occasioned by the misplaced confidence of a servant in the capacity of a Bombay jar to hold flowers and water. I was calling on the proud possessor of the pot, and when I was shown into the drawing-room, the flowers placed in the pot an hour or two before were looking very sad; most of the pattern and glaze originally on the vase had fallen, and was scattered about upon the silk piano cover; while the water, obeying the laws of gravity, had found a resting-place in the interior of the grand piano.

Despite its failings, however, the sale of this pottery in England, reached the respectable figure of £6,000 or £7,000 annually, but as the merchant in Bombay who exported it recently informed me, the demand suddenly ceased. When he made inquiries as to the cause, he was told by his agent in London that the Bombay pottery had been entirely superseded by pottery imported from Japan, which was harder both in body and glaze, was not subject to any of the drawbacks I have mentioned, and was quite as cheap. When my informant suggested that the mechanical defects of the Bombay pottery might be remedied he was told that the Sind potters only knew the rule of thumb methods they had inherited, and knew nothing of the scientific basis of their industry. This statement I can well believe, for whenever I have suggested improvements in the technique of their work to these men. improvements based either upon notes made by me during a six months' stay in the Potteries of Staffordshire about 25 years ago, or such as I had gained from books, or such as were dictated by common-sense, I was

always met with the complaisant admission that, although my suggestions might be all right, the method proposed was the English one, which the potter did not pretend to understand. The result was that an important artistic industry capable of employing designers, modellers, and painters trained in the School of Art, was stamped out at its very beginning by the superior knowledge of its mechanical details on the part of foreigners.

I have dwelt somewhat fully upon the artistic failings and the economic decay of the modern craft-workers of India, due firstly to causes found within the country, and hastened by competition from without, not from any wish to paint the situation in colours of an unnecessarily sombre hue, nor from any want of faith in the capacity of the Indian craftsman to do in the future as excellent and characteristic work as he has given to the world in the past, but because it is absolutely necessary to realise the present unfortunate position of the craftsman and the altered conditions under which he had to work, to understand why the Schools of Art have been unable to fulfil the purpose for which they were founded fifty years ago, and because a complete recognition of these changed conditions must, in my opinion, form the basis of the teaching given in the Schools of Art to the craftsmen of the future if artistic or economic improvement is to be attained.

The Work of the Schools of Art in the Past.

I come now to the question of what the Schools of Art have done in the past, and once again I must point out that my knowledge is chiefly confined to the work of the Bombay School of Art in that city and in Western India. Firstly, however, I must ask you to consider the extremely difficult nature of the task they have been set to perform, when compared with that allotted to similar schools in England and on the Continent. To begin with, in the whole of British India, with its population of close upon two hundred millions, there are only four Schools of Art, each separated from its nearest neighbour by a space of nine hundred miles. Only one of these schools, that at Bombay, has ever had continuously upon its staff two Europeans specially trained and competent to direct its policy and studies. The whole burden of the direction of each of the other three schools has, except for very short periods, been thrown upon the shoulders of a single European. The only expert assistance available in the craft schools has been supplied by workmen taken from the bazaars, scarcely any of whom have been able to read English. The great bulk have, therefore, been cut off from the possibility of consulting modern text-books dealing with their particular crafts, which they have never been trained to teach.

The principals of the schools have had many purely administrative duties allotted to them quite outside those connected with the schools, such as the holding of examinations, the direction of museums, the organisation of exhibitions, and the writing of industrial monographs.

When, therefore, you consider the inadequate number of the Schools of Art for the task imposed upon them, the isolation of their directors from *confrères* engaged in similar work, the nature of the expert assistance they have had, and I may add the character of the climate in which they have had to work, and contrast these with the thirty Schools of Art to be found within a six-mile radius of this hall, carried on by an aggregate staff of nearly 400 professors and instructors, each a highly trained practitioner in his special subject, which he is also competent to teach; adding to this that all are able to give their undivided attention to the objects for which the schools were founded, and that the schools are supported by public grants which if proposed by the head of a School of Art in India would lead to a medical inquiry into the state of his mind, you will not be inclined, I am sure, to criticise harshly the labours of such devoted and enthusiastic workers in the past as Mr. Lockwood Kipling and Mr. John Griffiths if, despite the utmost they could accomplish, they found it impossible to prevent the crafts of India from reaching the plight I have shown you they are now in. They bore the heat and burden of the early days, when even in England the policy of Schools of Art was in its experimental stage, and when in India such schools were often looked upon as little better than expensive fads forced upon Government, and bearing little or no relation to the practical business of the country. They had to struggle through periods of alternate neglect and encouragement, according to the individual tastes of succeeding Governors and Lieutenant-Governors, not to mention Directors of Public Instruction, which made continuous development impossible, and were at one time faced with the threat of the complete extinction of their work. We who have succeeded to their labours are filled with admiration at the

devotion and persistence our predecessors displayed, and if in the light of experience some of us are of the opinion that other methods are required to meet the vastly changed conditions, this does not lessen by one jot our appreciation of the many services they rendered to the cause of art and art-teaching in India.

In fact, the task was a hopeless one from the very start, unless, as I have before observed, India could have remained isolated from the rest of the world. From their commencement, the Schools of Art failed to attract the sons of working craftsmen, who were unable to perceive the advantage a knowledge of drawing would be to them in their daily work. The classes were, therefore, attended principally by boys and young men, who had taken advantage of the literary education supplied by Government. These youths belonged, in many instances, to castes that had supplied craftsmen, but they had no intention of following the crafts of their fathers. They looked for employment in one of the professions, or under Government, and with very few exceptions disdained to work with their hands. The artistic industries gained nothing, therefore, from the schools during the early years; but in other directions considerable use was made of these more highly-educated students. Mr. Griffiths was able to establish a training school for drawing teachers, and by means of the pupils passing through it to introduce the study of drawing into every high school, and most of the aided schools in the Bombay Presidency. He created a body of trained teachers of drawing, which eventually enabled Government to make that subject a compulsory one in the majority of the schools of the Presidency, and this has brought to light many students possessing aptitude for artistic work.

Under his supervision, the drawing, painting, and architectural students of the school have copied most of the finest monuments of the past in Western India, and the library of the School of Art in Bombay now contains sketches, models and measured drawings of so complete a character, that it would be quite possible to reproduce them, should the originals be destroyed by accident, or fall into decay.

That decay may possibly be the fate of some of the most interesting artistic records of the ancient civilisation of India, even in these days of active interest in the archæology of the country, and energetic endeavour to preserve its ancient monuments, was strikingly brought to my notice when I recently visited the cave temples of Ajunta. The valuable paintings upon the walls of these caves are darkened and otherwise injured to a degree that renders large portions of them undecipherable. Not one of them but shows the effects of time and neglect upon its surface, and unless some determined effort is quickly made to preserve them from further decay the careful and complete copies made by students of the Bombay School of Art under Mr. Griffiths's superintendence will be the only record future generations will have of these unique works.

Every Government department, as well as the drawing-offices attached to municipalities, is to a great extent indebted to the Schools of Art for the supply of the trained draughtsmen they employ, while openings for educated youths have been found through the school training, in the offices and studios of practising architects, engineers, and photographers throughout the country.

Although the course of events has been too powerful for the Schools of Art to succeed in preserving the crafts of the country from European influence, they have through their craft schools given a training in drawing to many hundreds of young craftsmen, such as it would have been impossible for them to have otherwise received, and by insisting upon careful workmanship, and by reproducing only the best examples of the works of the past, they have set a standard to the bazaars of India which would have been the means of saving modern Indian craftwork from the principal failings I have noticed, but for the fierce commercial competition to which the working craftsmen have been subjected.

The work of our predecessors in India needs therefore no apology or defence from us who have succeeded to and benefited by their labours. With inadequate means they successfully strove in many directions to reawaken the latent artistic spirit of her people, and they created that interest in Art among the educated class of the country, upon which future progress must depend.

They did the same kind of pioneer work that was performed by those who conducted and controlled the Schools of Art in England for the first thirty years of their existence, which cleared the path for the remarkable advance in artistic education we now see throughout this country.

The Future Policy of the Schools of Art.

Having attempted to give such a sketch of the present condition of the crafts of India as is necessary to understand the problems the Schools of Art are faced with, and to offer what I feel to be but an inadequate account of the work those schools have done in the past, I will proceed to deal with the more important question of what the future policy and function of the schools should be.

During the nine years in which I have studied the subject upon the spot I have been forced unwillingly to discard many of the prejudices with which I landed in India. With many hundreds of youths passing through the School of Art, whose personal careers and future usefulness to the country depend in a great measure upon the instruction the school affords, it has been necessary to put aside one's own preconceived ideas and artistic predilections and look at the hard facts of the case as they are and not as one would wish them to be. What those facts are I have already described, and their consideration has led me slowly and unwillingly to the conclusion that although the artistic capacity of the people of India is present, the ancient craftwork of India is as dead as the art of the Greeks or as that of the Renaissance in Europe.

Like the magnificent works of the Greek and Renaissance artists, those of ancient and medieval India must always serve as types and examples full of inspiration to students. Progress, however, can no more be achieved by limiting the art-workers of India of to-day to the servile copying of those masterpieces, than it could have been if the artists and designers of Europe had been only allowed to reproduce the masterpieces of Greece or Italy. On the contrary, the copying of the old designs has been the cause of the mental atrophy which distinguishes modern Indian craftwork from that of the Mughals, and I feel convinced that the artistic regeneration as well as the economic salvation of the craftsmen of India will never be brought about until they follow the example of their *confrères* in Europe. They should regard the great works of the past as inspiring standards of taste and achievement, but must cease to sponge upon their ancestors for artistic ideas. They must be trained to understand the principles upon which their ancestors built up their designs, and apply those principles to the inexhaustible storehouse Nature offers to the designer in India. Then I believe we shall have living and characteristic work consistent in every part in place of the dead copies or anachronisms we now see.

At the same time, the Indian craftsmen must adopt the same efficient mechanical and scientific methods of production as are employed by their Western rivals if they are to preserve their markets from invasion or are to capture new ones, while the rising generation of artworkers of every class and degree must be trained to meet the requirements of their clients as efficiently as the students in Schools of Art in Europe if they are to take advantage of the new fields for profitable employment the increasing wealth of India now offers them in the decorative arts. India must do for her artistic industries what Europe did long ago and what Japan has rcently done, transform them from an aggregation of isolated craftsmen to organised and skilfully directed combinations of workmen.

How can these changes be brought about, and what part can the schools take in them? Firstly, the teaching in the Schools of Art may be made less antiquarian in its character, and the students, while not ignoring the past, may be brought into closer touch with Nature, and be taught the manner in which natural forms may be applied to design. Steps in this direction have already been taken in Bombay, with results that have confirmed me in my belief that the decadence of Indian craftwork is not due to any weakening of the special aptitude the people of India have always shown for the decorative arts, but is owing to the fact that they had ceased to go to Nature for their inspiration.

I have ventured to place on the walls of this hall specimens of the original drawings and designs done by young students in the design classes of the Bombay School of Art, and drawing classes of the High Schools under a system recently introduced. Many of these students are mere children, and very few have been studying for more than two or at most three years. The drawings and designs have not been specially selected for this exhibition, but as will be seen by the marks inscribed on many of the drawings, they have been taken from the drawing-books used in the ordinary course of study.

The valuable point about these drawings and designs is in my estimation that each one is the original outcome of an individual student's own ingenuity. The drawings of simple objects and Indian plant forms have been made from Nature and from memory. A few problems in geometry have been learnt, and by arranging

the natural forms on a geometrical basis designs have been developed. As different flowers have been used by each student, or different geometrical bases have been used for the same flower, different designs have resulted. The memory drawings, which represent objects in the pupils' homes, were all done within fifteen minutes, and certainly appear to me to exhibit extraordinary facility when compared with the same kind of work done by European boys of a similar age. They show that the power of drawing from memory, which is a gift only occasionally met with in Europe, is almost universal in the East wherever the power to draw at all is present.

I have no desire to exaggerate the importance of these drawings, which are merely school studies; but I think they give reasonable assurance that the Indian designers only have to be shown how to use their minds to produce as vital work in the future as in the past.

It is useless to train designers if the objects they decorate are of such faulty construction or material as to render their labours valueless. I have already described how the Bombay pottery was driven out of the English market by the superior technical qualities of the pottery from Japan; while there is no pottery made in India at the present time that for quality can compete with the porcelain and tile work of Europe, which is being imported into India in large quantities, and the same superiority is to be seen in the materials used in nearly all the artistic crafts.

With the object of bringing up the materials and processes employed by the artistic craftsmen of India to the level of the practice in Europe, a technical laboratory has recently been attached to the School of Art in Bombay, and a well-equipped building has been erected in which four European experts will enquire into and improve the technical processes employed by the Indian potters, weavers, calico-printers, metal-workers and cabinet-makers. One of these experts is already at work, and as the appointments of all have received the sanction of the Secretary of State, I trust before very long all four will be conducting research work calculated to remove the worst of the faults now noticeable in the materials the Indian craftsmen employ.

Attached to this laboratory will be a normal school for craft teachers, in which selected students from the School of Art and its workshops will be trained to take charge of local craft schools as they are gradually established throughout the presidency.

Two steps have thus been taken by the Government through the School of Art in Bombay in the direction of equipping the Indian craftsmen and students of art to meet the competition of the West, but before design students, trained in the School of Art, and technical scholars, trained in the laboratory, can be trusted to superintend commercial undertakings, opportunities must be found for them to gain practical experience in workshops or design rooms where work is carried on under business conditions. In neither the School of Art nor the laboratory can such experience be obtained. The function of the former is to teach and not to engage in business, while the function of the latter is to carry out research work for the benefit of the Applied Arts generally, and to train teachers for the local craft schools. All attempts that have hitherto been made to mix up business with teaching in the Schools of Art in India have proved either educational or business failures. It stands to reason that the sudden intrusion of contract work into the midst of a carefully planned and graduated educational course must destroy its continuity, while any attempt to carry out decorative work by novices learning their trade leads to great waste both of time and material, for the work has to be done several times over, and generally has an unsatisfactory result. Of course, this does not mean that the graduated exercises in the school are to be dry academic studies useless for any purpose when completed, and I have placed a few photographs of work done in the workshops attached to the Bombay school to show that this is not the case, but the execution of such work is a very different thing from that of taking a contract for work that has to be finished in a given time and must be up to a certain standard.

Lack of Opportunities for Practical Training in India, and suggested Remedy.

In England this opportunity for the practical training of art students outside the schools is afforded by the studios and workshops of the large and wealthy firms by whom applied art work is chiefly carried on. These studios and workshops are superintended by designers possessing, in many instances, talent of a very high order, assisted by thoroughly trained and experienced craftsmen. A student engaged in one of these studios or workshops gains a knowledge of design and work it would be impossible for him to acquire in a School of

Art only, though he is able, by the study of advanced drawing and design in the evening classes of the school, to supplement his studio and workshop practice. Thus studio, workshop, and school work together, each supplying what the other lacks, and combine to keep up the numbers of experienced designers and trained craftsmen capable of taking the places of the elder men as they retire, or of providing reliable superintendence for new enterprises as they are started.

As there is an almost unlimited supply of trained designers in England, capitalists investing money in applied art work can, by paying for it, command the services of the best talent in the country. In India, on the contrary, there are scarcely any trained designers at all, and by their absence capitalists are prevented from engaging in business in this direction, while the art students in India are deprived of those opportunities of gaining practical experience enjoyed by the students in England.

It is quite true that an Indian firm might engage the services of an expert European designer to superintend their drawing office, but it is very doubtful if sufficient inducement to leave England could be held out to the best in the profession. Remuneration would have, in any case, to be offered on a scale that would render the commercial success of any such undertaking extremely problematical. To import second-class men, or those who had been failures in England, would be worse than useless; it has already been tried with disastrous results both to the men themselves and the capitalists who have engaged them.

The absence of trained designers in India has in another direction affected the chances of the students of the Schools of Art obtaining remunerative employment. It has reduced the architects to the alternative of either cutting out the greater part of the ornamental portions of their designs which involve artistic work of a high order, or of going to a European firm to supply them. Several instances of the former alternative having been forced upon architects against their inclinations have come under my notice, while in the case of four palaces now being erected in Western and Central India, upon the interior decorations of which a sum of over £20,000 is being spent, every penny laid out upon artistic work will go to European firms and their employees, instead of to the artists of India, because the latter lack the experience necessary to the designing of the work, and no firms can be found in India capable of satisfactorily undertaking its execution.

At the same time, students who have spent years studying in the Schools of Art, and who would be quite able to do this work, if properly directed, are unable to earn an adequate living by their profession after leaving the schools. They, therefore, drift into other occupations, or remain idle, and naturally feel disappointed and discontented at the unsatisfactory position they find themselves in after their long period of study.

How can opportunities of gaining practical experience be provided for the art students of India, and what inducements can be held out to Indian capitalists to engage in applied art work? As is usual in India, I fear Government will have to show the way, and a means exists of doing so through the agency of the Architectural Section of the Public Works Department, at very little extra cost compared with the inestimable value it will be to the art students, and through them to the advancement of the applied arts in India. At the present time, although Government spends many thousands of pounds annually upon the fittings and decorations of new buildings, and upon the repairs and renovation of old ones carried out under the supervision of the Public Works Department, it must be admitted that such work, when done by Indian contractors is, as a rule, greatly below the standard of Europe. In my own bungalow, for instance, I have seen house painters putting on the coats of paint with a rag, instead of brushes, and applying them by means of their feet, instead of their hands—though I do not venture to assert that this is the universal practice of the house painter in India. Neither should I like to state positively that they never take off the old coats before applying the new ones, though I must say I have rarely if ever seen it done. It is undeniable, however, that anybody who knows what good work is, cannot fail to notice the inferiority of the decorative work in modern Indian buildings as compared with that in England and on the Continent, and the same remark applies to the rest of the interior fittings.

To remedy this I suggest that Government should establish a drawing office or studio with a certain number of workshops attached, in which the best decorative work to be placed in public buildings could be designed and made. The whole establishment might be under the control of a small Board consisting

of the Consulting Architect to Government, an Engineer or Accounts Officer of the Public Works Department and the Principal of the School of Art, and should be run on purely business lines.

A trained designer to superintend the work would not at first be required, as most of the designs for details would be supplied by the Consulting Architect, which the staff of the School of Art could see accurately carried out, while the European experts in the technical laboratory would supervise the preparation of the materials used. The staff for both drawing office and workshops would be recruited from the schools of art and their craft schools.

Such an establishment would supply the link which is missing in the educational chain that should join the Schools of Art with the practical craftwork of the country. It would ensure a better standard of work being done in the decoration and fitting of public buildings. It would certainly be the means of introducing new artistic industries into the country, and it would serve as a model to the craftsmen and capitalists of India, and by gradually providing trained designers and technical experts would be the means of inducing these capitalists to engage in industries connected with the applied arts. It would be the means of opening a wider field for the profitable employment of the educated classes, and would secure to the skilled handicraftsman of India a preponderating share of the craftwork that is now being executed abroad.

If for excellent reasons Government already makes it own guns, gun carriages, ammunition and transport wagons, builds its smaller boats and does its own repairs, and if the municipalities and the railway companies find it to their interest to maintain their own drawing offices and workshops, I cannot see any reasonable objection against, but many reasons in favour of Government executing the decorative painting, artistic metal work, cabinet and tile work in public buildings through the medium of a Government drawing office and workshops.

A few contractors may lose contracts they now obtain, and a certain number of unskilled workmen may have to find work in other directions, but against this must be set the fact that Government will have the work done more efficiently as it will be done under skilled supervision, they will be showing the way to both capitalist and craftsman, and they will bring the art schools into touch with the practical work of the country in a manner not seen in India since the time of the Mughals.

The influence such a drawing office and workshops will have upon the teaching in the Schools of Art will be as striking as the effect their establishment will have upon the character of the decoration of the public buildings themselves. With the prospect of profitable employment open to them, intelligent and talented students of every class will join the schools, and their subsequent absorption among the art workers of the country will relieve the overcrowding that is now felt in the other professions. Having definite objects in view the teaching in the schools of art will become more practical, and instead of being tied as they now are to the low level of the bazaar, the craft schools will be forced to train their pupils to fit themselves for employment in a drawing office or workshop carried on upon European lines and under commercial conditions.

It may be reasonably expected that as experienced designers and technical experts become available capitalists will come forward to establish similar studios and workshops. When this happens it will be an easy matter for Government gradually to decrease the output from their own workshops or to hand them over to be carried on by private enterprise. But until these designers and experts have been thorougly trained in practical work, and this is the real root of the whole problem, it appears to me that both in the interest of artistic education and for the economic future of the craft-workers of India, Government should follow the example it has set with regard to the more urgent, but not more important, requirements of the military and naval services and establish such a studio and workshops as I have roughly sketched.

I fear that in the observations and suggestions I have offered this afternoon I have laid myself open to two criticisms, and these I will now answer in anticipation.

The first is that in dealing with the subject of Indian art and art schools I have taken too low and commercial a view of the subject: that art in a school should be treated as an ideal and abstract subject and should be studied apart from such a practical consideration as the possibility or otherwise of art students being able to earn their living after they leave the school; that the value of a School of Art lies in the elevating effect the study of the ideal works of the past has upon its students, and through them upon the

national taste; in short that a School of Art should concern itself solely with what have come to be considered the Fine Arts and should leave the crafts of the country severely alone.

This criticism is based upon the assumption that there is a dividing line between the Fine and Applied Arts, an assumption which gradually came into existence in Europe during the eighteenth century, which brought debasement to the crafts of the early nineteenth century, and has been combated by the best writers and workers since. The greatest painters and sculptors of the past such as Holbein, Dürer, Francia, Cellini and Michael Angelo, as well as many of the finest of the moderns, such as Flaxman, Alfred Stevens, Alfred Gilbert, and, if he will permit me to mention his name, our Chairman this evening, have by their practice proved the falseness of this assumption, and have demonstrated the unity of the arts with the crafts.

Government schools have been founded both in England and India for the special purpose of equipping the craftspeople of each country to meet the competition of their rivals throughout the world.

Recognising the fact that although individual artists may be willing to undergo privations amounting in some instances to actual starvation in the pursuit of an ideal, bodies of craftsmen will cease to follow any occupation which fails to afford them a reasonable living, Governments have fostered the crafts and have for the most part left the teaching of painting and modelling to private enterprise.

The teaching of the Fine Arts has, however, not been altogether excluded from the curriculum in Government schools, but the way to them has been through design and craftwork, and has not been separated from them. In India especially, where painting and sculpture had never been considered except as parts of the decorative scheme of a building, or some other composite work, until the idea was imported from Europe in modern times, it appears to me to be desirable that this order of progression should be maintained in Government schools. If these schools succeed in producing a class of thoroughly well trained designers and craftsmen, who can obtain a sure living by their efforts after leaving the school, they will have performed a valuable function in the State. If among these designers and craftsmen there should be found men of exceptional ability in any direction, opportunity for further study should be available, when their previous studies in design and craftwork will have provided the soundest educational foundation they could have been given. But for a Government school to turn out numbers of indifferent painters and modellers, such as we see coming annually from the private art schools of England, who cannot obtain a living by their work after they leave the school, whose training there unfits them for the service of the Applied Arts and generally for any useful pursuit in life, would not only be an ill service to the State, but would be contrary to the intention with which the schools were founded.

The other criticism of my suggestions will probably be that, if carried out, the ancient character of the Indian crafts will be destroyed. To this I reply that Art never stands still; if it is not progressing it is decaying. For the last hundred and fifty years Indian art has decayed because the craftsmen were content to let their ancestors do their thinking for them, and progress can only be achieved by encouraging them once more to think for themselves, and by teaching them how to embody their thoughts in their work.

The work of the past we all admire was produced by men who thought for themselves and were not content to copy the work of those who preceded them, and it was the outcome of the conditions of the time in which they lived.

Those conditions have now entirely changed and can never be brought back again, but so long as Nature in India offers combinations of form and colour not found in Europe, and so long as the Indian designer imbues those forms with the mental characteristics which separated his art in the past from that of the rest of the world, there can be no danger of Indian art disappearing or of it being dominated as it now is by the art of the West.

DISCUSSION.

The CHAIRMAN (Prof. Sir Hubert von Herkomer) thought the paper was a very practical one, and it seemed to him the gist of it was an appeal to bring a traditional art up to date, not an impossible thing, though a difficult one. To copy merely a traditional art would have no more artistic meaning than to take a cast of a corpse, and a corpse was not a nice thing to live with even as a cast. The tradition once had a vitality, but that vitality lessened and ceased as years went on. It was with man's handiwork as with man's life; Eastern nations, full of romance, talent, and latent power, were in a transitional state, and it was

important that they should get the right help from the Western nations. For that purpose only the best men should be allowed to teach and those men should be adequately paid. Second-rate men were far more mischievous than no men at all. The paper breathed the right spirit; it was based not only on common-sense but on data gathered by the author himself, and he certainly hoped as an old teacher that Mr. Burns's advice would be taken. The great thing appeared to be the need of some central organisation from which branches could be worked, and at the head of that central organisation should be a strong man with unlimited power. Such a man should not have to fight officials, a great drawback to good work not only in India but in this country. He trusted that the common-sense of the paper would be taken to heart by those who had the power to bring it to fruition.

Sir GEORGE BIRDWOOD said that he wished to introduce to the meeting some examples of Indian domestic, and village, and urban art, in demonstration of the truth of his own life-long contention, tacitly contradicted by Mr. Burns, that in all her immemorial historical arts, weaving, pottery, jewelry, carving, &c., India was living India still. He had fought that battle out in official reports, and other publications, from 50 to 60 years ago; and had no wish, in the circumstances of pleasantness and benignity wherein they were there assembled, to fight it over once more in that revered room,—new-enkindling a sleeping fire for the purgation of the self-same heresies twice and thrice again. Strongly as he held his own views on any controverted point, he held to them in the true spirit of a student of the life in which he found himself, well recognising that in confuting the errors of the past we are too often but establishing in the present fresh errors for correction in the future. Moreover, as a matter of grateful consideration towards Mr. Cecil Burns, he would very much prefer to enlarge on the many questions on which they were agreed, than to treat of the few whereon they stood at variance. After coming safely all the distance from Bombay to address them there as he had done that afternoon,—and with so great ability and fulness of experience, and enthusiasm, and distinction,— they must not damp down the true Promethean fire that animates his breast by lavendering him in the "allaying Thames" as it laps past those painted walls! Obviously Mr. Cecil Burns's paper was of unusual interest and value, and exemplary and admirable alike in its accumulation of far brought facts, the clearness of their exposition, the force of their suggestiveness, the significance of the conclusions drawn from them, and the earnestness with which he had urged them on their attention. But for these very reasons it became all the more his duty to demur to Mr. Burns's tendency to regard the traditionary decorative arts of India as dead,—at least as dying,—an assumption he had unhesitatingly to meet by a direct, explicit, and emphatic negative. Mr. Cecil Burns in effect said, and their eminent Chairman expressly said, that the Eastern nations were not in their present state of transition exercising to the full their latent artistic powers; and that it was therefore of great importance that they should get the right help to this end from the Western nations. And again, Mr. Burns said, in so many words, that India must do for her artistic industrials what Europe did long ago, and what Japan has recently done, and transform them from an aggregation of isolated craftsmen into organised and skilfully directed combinations of workmen; and as a step to this end he suggested that the Government of India should establish in various centres a drawing office or studio, with a certain number of workshops attached to it, in which the best decorative work, to be used on public buildings, could be designed and made. The Government would thus, he went on to say, show the way to both capitalists and craftsmen to bring Schools of Art into touch with the practical work of the country in a manner not seen in India since the time of the great Emperors of Delhi. Now those practical recommendations were right enough so far as they went; but they were partial, and, indeed, absolutely disparate, both in their aim and end,—the improvement of the ornamental details on public buildings in India, and of the artistic articles of Indian industry required for exportation to Europe and America: and lop-sided and imperfect also in the means proposed for attaining these results,—the official training of the craftsmen of the great polytechnical cities of India in draughtsmanship,—that is European draughtsmanship of the flowing line; the mastery of which, let him add, would, if exercised in the reproduction of Oriental designs, at one stroke transform them into occidental designs, and be the utter destruction of the Warangal type of Indian carpets, the most classical Oriental type of carpet, not only in India, but anywhere in Asia,—or modern Europe, including America. This disparity of Mr. Cecil Burns's apprehension of the problem before them, and of the solution of it advanced by him, is the fundamental explanation of his undiscriminated notion of the growing failure of the craftsmen of India in artistic sensibility, and in the power to embody their mental and emotional interpretations of nature in the terms of art, as applied to the utilities, amenities, and reverences of the common daily life of their country folk and country. "Toto cœlo"—he separated himself from so despairing a view of the present and the future of the Indian craftsmen; who are to this day, intrinsically, in every respect, capable of sustaining their reputation of the past in its greatest periods, to its highest pitch; any default in their traditionary inspirations and manipulative sleights being observable only where the opportunities for their free and untrammelled exercise are closed to them by the overwhelming and overmastering competitions of Europe and America; and, in an insignificant and utterly negligible proportion, of our Schools of Art,

where these have been, from time to time, degraded from their higher objects, and debased to the status of commercial factories, for the purpose of providing an income out of the penurious pocket of the personally-conducted "globe-trotter" in part repayment of the costs of their maintenance by the State. Mr. Cecil Burns took no account of the hereditary and sacro-sanct craftsmen of India; an omission which, if not absolutely fatal to his pervading polemic, at least vitiated it throughout in its data and its deductions. What this amazing hiatus means may be somewhat measured by the fact, brought out by calculations he (Sir George Birdwood) made from 50 to 60 years ago for the *Bombay Saturday Review*, that the output of the village hand looms of India, for local disposal, could not be fixed at less than the total machinature by Manchester of cotton piece goods for both home and foreign consumption. Still it is the Moloch of Manchester that is the actual menace to the greatest of all the artistic manufactures of India after pottery. It is impossible to estimate the prodigious production of the hand-thrown pottery of the Indian villages. No earthenware pot or pan can be used twice over for cooking food or personal ablution by the twice born castes of India; a rule of ritual that from a timeless past has constituted India the potters' paradise: and it is the shards accumulated, under the operation of this religious custom, in and about the villages of India, that through the ages have gradually upraised their foundations above the level of the surrounding fields and orchards. And so far, he (Sir George Birdwood) had observed no falling away in the productiveness, or the art, either of these rural hand-looms or potters' wheels. And as for the illiteracy of the Indian craftsmen of which Mr. Cecil Burns had complained, they are, as found in the village communities of Western India, the most literary peasantry in the world, not excepting those of France and Scotland (which received most of its "culture" from France and Switzerland), and spend all their evenings in the wrapt enjoyment of recitations from their great national epics, the Ramayana and Mahabharata and the religious and patriotic poems of Tukaram. It is as if our agriculturists and artizans spent their evenings around our parish churches and on our village greens, in popular readings from Shakespeare, Milton, and Swinburne! Mr. Cecil Burns dealt, indeed, only with the nomad craftsmen who have been accustomed from time immemoral to travel over all India and Asia, and Northern Africa, and Southern Europe, to the very confines of France; and who in India are now, under the beneficent influences of the "Pax Britannica," largely represented by the sedentary craftsmen of the bazaars of the great polytechnical cities, such as Bombay, Surat, Ahmedabad, and Baroda; where, however, even these reclaimed wanderers, when they happen to be Hindus, are severely organised in trade unions; and where the sumptuary industries carried on by them, such as embroidery in gold and silver, and jewelry, still flourish as healthfully and serenely, and in as superb and supreme beauty and glory, as ever under the greatest of the Mo(n)gol Emperors of Delhi. They show no more signs of decay in their technique or their artistry, than do the more strictly sacramental, because more directly utilitarian, simple handiworks of the hereditary craftsmen of the democratic villages. It is true that, for the most part, they work in more or less complete isolation; and that may be to their detriment in some respects, for it may bind them too hard and fast to tradition; but it is certainly to their advantage in many ways, not the least being that it prevents their being moved by such sudden changes in fashion as those to which the artistic industries of the West—Europe and America—are exposed, often to their utter disorganisation and lasting degradation, as seen in the inane and crazy "creations" of "*l Art nouveau*." But Mr. Cecil Burns seemed to him to be positively obsessed by the idea of teaching the craftsmen of India,—that is of the great polytechnical cities of India,—to manufacture his handiworks more in the taste and fashion of the "machinations,"—the mere merchandise,—of Europe and America, and in direct competition with them. It is all of a piece, only more "villainously so," with our substituting in the literary education of people of India, Shakespeare and Milton and Swinburne for Valmiki and Dwaipayana [the reputed author of the Mahabharata] and Tukaram:—and of course what we Western Aryas of Europe and America want from India are "Bombay Mangoes," and not "Kentish Pippins,"—while, where there is any demand in India for English apples, it is not for imperfectly acclimatised Apple-johns, withered afore they ripen, but for sacks upon sacks of them, brightly red and green, and green and white in the bite, fresh from the orchards of Kent or Devonshire,—their pips all deeply embrowned to chestnut, propitious for divinations!—and there, indeed, lies a real link of community between "the East that's always Least," and the West that is never at rest. In his (Sir George Birdwood's) own judgment the wisest policy to adopt with the Indian craftsmen was to leave them alone, and severely alone, to pursue in their own markets, rural and urban, the artistic industries in which their excellency had been recognised from the beginnings of the authentic history of the Old World. But if we must exercise ourselves over their education, he saw no objection to providing them with instruction for perfecting them in the mechanical details of their work, the factor in artistic industries in which by universal consent we have hitherto stood preeminent. This is what had been done, within the memory of so many there that afternoon, so successfully by Mr. Chisholm in Madras, Mr. Griffiths in Bombay, Mr. Havell in Calcutta, and John Lockwood Kipling in Lahore. Mr. Cecil Burns also from his first landing on the Island of Bombay approached the Indian craftsmen of the City of Bombay, and of the other polytechnical cities of Western India, in the spirit of

a similar intelligent and sympathetic appreciation of the artistry of their several crafts; and sought to excite in them some sense of the advantage to themselves of putting improved mechanical work, of the various kinds required, into their productions; but he was going too far (Sir George Birdwood said) when he went on, in the paper he had just read, to insist on the Government assuming the position of a capitalist controlling combinations of these urban craftsmen, and turning the Schools of Art into some sort of State factories simply to promote the commercial exploitation of the artistic wares of India in Europe and America. The Government would only lose the money risked on so uncongenial an adventure, Indian art would be more than ever degraded and depraved by it, and another disintegrating blow would be dealt to that democratic caste system, which was the one solid and sound foundation of the social order and security, and peace, and happiness, of the Hindu communities of India. But this was entering into the domains of political economy, and administrative policy, while all he (Sir George Birdwood) was concerned to press home was the fact—and it should be the all-controlling fact—that no one who knows the craftsman of India, rural or urban, as we find him throughout the length and breadth of that immense outstretched peninsula, from "the [Himalaya] Mountains to the Bridge [Adam's]," and from Tatta to Dacca, but must accept him in the artistry of his handiwork—whatever its mechanical defects—as the master art craftsman of the world; who never had a rival but in his brother Aryan craftsman of Hellas, from whom [from about B.C. 250 to A.D. 250] he learnt so much of his higher arts, as architect and sculptor, and the Saracens, all of whose art is Greek art adapted to their religious tenets and social usages [to this day the workers in Arabesques of Egypt are all Greeks]; but who has nothing to learn from any of the art craftsmen of America or Europe, who on their part have much to learn from him, for his art is not the foolish and vulgar expression of the fickle fashion of every idle passing hour as is theirs, but an art nourished in enduring health and strength directly by the Nature, under the chastening discipline of the traditions of three millenniums of unbroken social, literary, artistic, and religious culture: a culture wherein religion, and art, and literature, and the diurnal and annual round of human life, are indissolubly one, and in which he finds the fulness of a spiritual happiness, that carries him serenely past every material menace and misfortune that may befall him: and, wherefore, his (Sir George Birdwood's) prayer from his first knowledge of him had steadfastly been, in the words of Milton, "God stay him in that felicity!"

Sir George Birdwood illustrated these observations by casual examples of Indian art industries of minor denominations, the work of village and urban craftsmen, particularly those engaged in the service of Hindu temples, some of them spontaneous and untaught applications of European materials, such as beads, to immemorial Indian designs; some conventionalised directly from surrounding objects of Nature, the leaves and flowers, and seed vessels of trees of the Western Ghats; some, as the phallic case [resembling the "cista-mystica" of the Phrygians], of the Lingaits of Canara, symbolising universal Nature and the vital energy of Nature, within the limits of a pill-box; and some directly derived, in unimpaired traditions of form, from Babylonian, and Assyrian, and Greek originals: all the work of to-day, and as perfect in their art of to-day, as if they had come down to us from the days of our earliest knowledge of such ornamental objects: and he defied the most skilful of the manufacturers of America and Europe, to reproduce any of these objects in all the refinement and charm of form and decoration of the original designs The bead trinketry, for the adorning of the gods, had for years past been exhibited in Europe, and imitated at Vienna, and other pushing, hustling manufacturing centres of the West, but these counterfeits at once betrayed themselves by their clumsiness of construction, and crude and clamorous colouring. Finally he exhibited an Indian lady's slipper of coloured leather, the decoration of which was inwrought by scratching conventional floral scrolls through the coloured surface of the leather into its naturally light brown coloured substance, with the most exquisite delicacy of touch and fascination of effect. If, he said, there was any young lady in the room wearing the fellow to that sweet, dainty, Scythian slipper, at the close of the meeting the Fairy Prince would be at the door downstairs with his carriage and pair to drive her to her home.

Mr. Lewis F. Day, referring to the second of the two criticisms anticipated by Mr. Burns, thought that he did lay himself open to the suspicion of suggesting a course which would have the effect of doing away with something of the character of Indian art. He was surprised at the Chairman's interpretation of the paper as a plea for tradition. To him the anchor of it had seemed hardly to appreciate tradition in art at its true value. Mr. Burns scored a point when he suggested that to found yourself upon tradition was to let your ancestors do your thinking for you. But that was not quite a fair way of putting it. Tradition was the sum of all experience; all advancement in art started from it—more especially, one would think, in a country where caste prevailed. It was tradition which had brought Indian art to the perfection it had once reached. If Indian art was now as debased as Mr. Burns seemed to say, it might be necessary to hark back to Nature. But the starting point should still be tradition. Modern conditions had also, no doubt, as Mr. Burns said, to be taken into account, and it was inevitable that, under our Empire, something of European influence would infuse itself into the Eastern idea. That, however, was a very different thing from the Europeanising of Indian art.

He should be sorry to believe that there was no demand, no scope for Indian art. If, following our architecture, Renaissance design was to be imposed upon the native, Heaven help Indian art! He preferred to believe in native art; and he thought that, much as the Indian craftsman might be helped by sympathetic and intelligent European guidance, he should be allowed to follow his inherited instinct and go his natural way. If he was to do anything worth doing he would have to stick to his Oriental traditions.

The CHAIRMAN said he did not see anywhere in the paper that the author wished to do away with tradition, but rather the contrary.

Mr. E. B. HAVELL (late Principal of the Calcutta School of Art and Art Gallery) thought that in all the discussions referring to Schools of Art in the last twenty years people had shut their eyes to the vital point at issue, namely, what was the use of one section of a department, a very small, insignificant section, preaching and practising principles of art which the rest of the department and all the other departments of the State utterly disregarded? In Europe nobody expected Government to be artistic, but in India things were very different. The people of India were an artistic people, or they were until Englishmen began to educate them, and they believed that the Government was artistic. Sometimes even Government itself believed that it was, and that made matters much worse. The real question was whether the British people individually, collectively, and administratively, were an artistic example to the people of India who followed their own artistic traditions. For example, taking the question of dress, he could never walk in any part of India in which the influence of English education had not penetrated without feeling that the peculiar sartorial embellishment which custom had imposed upon him was a blot on the landscape and a disfigurement to the delightful lines and colour Indian tradition had given to Indian men and women. Little progress could be made in the national art education of Europe until artists as a body had sufficient courage to defy the caustic wit of the street arab and the authority of the artistic critic of the *Tailor and Cutter*, and adopt some distinctive professional costume, more beautiful in line and colour than the things produced by the tailor of to-day. Then again, could any artistic European climb the wonderful hills round Simla and Darjeeling, and look down upon the corrugated iron roofs and hideous constructions with which the beauties of Nature had been disfigured, without a sense of shame, when he compared them with the really beautiful and dignified domestic and ecclesiastical buildings which the Indian builders of the present day were still producing? The keynote of the paper seemed to be that although the artistic capacity of the people of India was still present, the ancient craftwork of India was as dead as the art of the Greeks or that of the Renaissance in Europe; but that he disputed *in toto*, and he thought that when the author had been longer in India he would alter his opinion. He (Mr. Havell) had with him some illustrations of living Indian art, architectural sculpture, done within the last twenty years by men still living, and he thought Europe might be searched from one end to the other without finding any modern work better, and very little was half so good. The wages of such men averaged fourpence a day, and they were unable to get artistic employment, except of the most insignificant kind, because when the Public Works Department in Calcutta required architectural decoration it sent either to Europe, or Bombay and obtained men who had been trained in the Bombay School of Art to copy ordinary European ornament. It was not that the Government could not afford the luxury of architectural decoration, because in the last twenty years it had spent lakhs of rupees on such decoration in Calcutta. It preferred to pay ten or twenty times as much for good, bad, and indifferent, mostly bad and indifferent, European art, as it would have to pay for first-rate Indian art. That was an utterly wrong policy. Lakhs of rupees had been spent in the last ten years in restoring ancient monuments and every rupee of that money might have been well spent, but that was archæology, not art. It was archæology again when European architects or engineers designed buildings in which they called an Indian style and set Indian builders to copy their drawings. The true function of Schools of Art in India was to endeavour to persuade the Education Department, the Public Works Department, and other departments, to put artistic principles into practice as thoroughly as India had always known how to do for herself. In the book of illustrations he had with him, the Printing Department of Calcutta had turned one plate upside down, and he thought that was very significant of the present state of art education in India.

Mr. A. CHATTERTON (Director of Industries, Madras) thought that in some respects Mr. Burns had underestimated the degree of difference between the state of art industries in the various parts of India. Speaking for Madras, the ancient art industries were not so much dead as dormant. For a very long time there had been but few opportunities for the best art workers to make a living by the exercise of their artistic skill, and it was for this reason and to meet the demands of so-called dealers in Indian art wares and hawkers of the same that so much bad and inferior work had been turned out in India during the last half century. Much of the ill favour with which the work of Schools of Art in India had been viewed had been largely due to the fact that it was very often not understood. It was only a few years ago that it was proposed entirely to abolish Schools of Art in India because they were thought to be doing unsatisfactory work, and that in face of the fact that many of the men who had been in charge of those Schools of Art had achieved, if

not world-wide, at any rate Indian reputations in regard to the work they had done. He thought the present position of Schools of Art in India was largely due to the fact that the work they had done had been to a great extent to meet the immediate necessities of the moment. As times changed in India the constitution of the schools was not sufficiently elastic to enable them to adapt themselves to the altered conditions without constant reference to the superior authorities controlling education. If Schools of Art in India had been left more to those in charge he thought they would have done a great deal better work. That policy to some extent had been recognised in Madras, and the present superintendent there had very little to complain of in matters of that kind as he had been allowed a much freer hand than his predecessor had, and already there was evidence that if a capable man was allowed to carry out his own ideas and to modify them from time to time to meet the changing necessities of the case the result would be much more satisfactory than when the schools were bound up in cast-iron rules and regulations. In Madras they had not a School of Art but a School of Arts, and he took it the term had much the same significance as it had in the title of their own Society the "Royal Society of Arts," and because it suggested a school to deal with a very much wider range of subjects than was generally to be found in the curriculum of a School of Art, he thought it was a more suitable designation. Mr. Burns had shown that if art was to be revived in the future something must be done whereby the people who passed through the schools might make a respectable livelihood. That part of the question had been too much neglected in the past, and he viewed with satisfaction Mr. Burns's general agreement with the policy in Madras of providing practical training for artisans outside the schools. He preferred, however, to see the workshops more intimately connected with the School of Art than Mr. Burns proposed. It seemed to him it would be better to have a larger staff and to delegate to some of the staff the work of managing the commercial side of the institution rather than to provide for it being carried on by an outside and independent Board. Many difficulties would be lessened if the training of the students in decorative work was completed on the commercial side of the school under the superintendence of the Principal. In Madras they viewed the decay of Indian art as being mainly due to the lack of opportunity afforded to the better-class artisans, and a remedy had been adopted recently which promised to meet with success. The Victoria Technical Institute had agreed to devote its resources to an attempt to improve the status of the Indian art craftsman. In Madras they had built a memorial-hall to commemorate the reign of the late Queen, and had filled it with a large collection of the art products of the Presidency. All these articles were for sale, and with the sale proceeds fresh commissions were given to the artisans so that they might be kept constantly doing the best work they could turn out. For the present it was proposed to devote a sum of about a lakh of rupees to financing, as it were, the Indian artisans, as it was thought that if they could be brought into touch with a more appreciative market they would return to their old methods of working and produce once more the artistic work for which their forefathers were famous. The sales had largely increased, and a gratifying feature was that the place was to a large extent patronised by the Indians themselves, who expressed surprise at the beautiful work produced.

Mr. ROBERT F. CHISHOLM, F.R.I.B.A., most emphatically endorsed everything the author has said not only with regard to the history of the Schools of Art in India, but also to the very admirable scheme he had laid down as to the future of those schools and the way they should be conducted. He (the speaker) had practically tested the scheme, because in the seventies he had been allowed to use the school of industrial arts in Madras as an art workshop, and in that way to make the work of artisans really useful. He had thought that in a short time he should be able to improve the style of drawing in the school, making the institution self-supporting, and execute the buildings entrusted to his charge without having to indent on the Secretary of State for European articles. In three years he realised his most sanguine expectations. The drawings by the students were quite equal to those produced at South Kensington in the lower stages. The institution, which was a dilapidated set of sheds, was remodelled into a presentable institution, and the industrial art work of the post and telegraph office in Madras was entirely executed by the students, every article being supplied through the school of arts without a single foreign importation being used except pot-metal glass and pig-iron. Then two difficulties arose. On the educational side it was impossible to carry the students further without taking them into figure drawing, and to do that would be to destroy any lingering of native art that might exist, because it would be impossible, after teaching a student anatomy and the drawing of the figures to set him down to draw six arms on a single body, or to study flesh tones in the green or pink incarnations of Vishnu. On the industrial side in the lapse of time between one public building being finished and another commenced the school had to become a kind of State manufactory dealing with public funds. There was no objection to that, but it was impossible to carry it out without the support and co-operation of the Government. He thought Mr. Burns's scheme was the only way of solving the great difficulty connected with the industrial arts of India. No one could respect the ancient arts of India more than he did, but the question of what was the ancient art of India was one upon which very few people would agree. He had been shown one of his own pots by a lady collector as a specimen of a beautiful lost ancient art! He disagreed with

the author as to the cause of the failure of Bombay pottery. That failure was really due to the fact that an unwise attempt was made to make the pottery useful. The Bombay pottery, which was, of course, Sind pottery, depended for its beauty on the peculiar colours of oxide of cobalt, copper, and manganese, fired at a very low temperature, and the three resulting colours, a beautiful green-blue, an exquisite deep blue, and a sepia, were combined in the pottery with the most beautiful effect. If, however, the pot was fired in a high temperature the whole thing was ruined. The Sind pottery was beautiful both in form and colour, and he thought there might be a very valuable future for it if no attempt was made to make it useful. It should be regarded an an ornament and treated only as a vehicle for artistic display. The decision of the Government with regard to public buildings being built in the Renaissance style was deplorable, and must lead to the most deplorable results. The only art in India was the native art, and it must not be allowed to degenerate into a bad echo of Western art.

Sir WILLIAM LEE-WARNER, K.C.S.I., who occupied the chair during the latter part of the proceedings, in proposing a vote of thanks to the author, said the paper showed the highest sympathy with what there was good and ready to hand in India, especially the wonderful memory of the India people and the marvellous fertility and richness of Nature from which they could copy. How far Schools of Art could turn those natural advantages to greater value was a moot question. He had spent the whole of his life in endeavouring to see that Schools of Art, either in Bombay or elsewhere, were not destroyed, as they had frequently been threatened by the constant changing of ruling authorities. He wished that the discussion had more emphatically shown the advantages of maintaining even the little flicker of light that existed, for he believed that benefits were derived from the Schools of Art. He had been pleased to notice throughout the paper no word of grumble from the author, who, with his predecessor, had done disheartening work with cheerful heart.

Sir GEORGE BIRDWOOD seconded the motion, which was carried unanimously.

Mr. BURNS briefly acknowledged the vote, and the meeting terminated.

Mr. BURNS, who was prevented by want of time from replying to the discussion on his paper, writes :—

I desire to thank Sir William Lee-Warner and Sir George Birdwood for the kind and flattering manner in which they referred to my paper, and to the work I have been privileged to do in Bombay. I value Sir George Birdwood's appreciative words the more, because they have been uttered after listening to theories and suggestions which, I am aware, traverse much of the teaching of his whole life. Despite apparent differences, the end we all have in view is the same, namely, the preservation of Indian art from being so influenced as to be entirely supplanted by that of Europe. It is when the road to that end is discussed, that divergences of opinion appear.

In the interesting discussion that has arisen from my remarks and suggestions, I notice that those gentlemen who disagree with me as to the right way to our common goal have done so upon one or more of three grounds, namely, the accuracy of the facts I have brought forward, the soundness of the theories I have propounded, or the practical character of the remedies I have proposed. With regard to the facts, I can only say that I have attempted to give a true and unbiassed account of the condition of the artistic industries, so far as my observation of them goes, in Western and Central India. In other parts of the country the outlook of the indigenous craftsman may be brighter. I trust it is so, but what cannot be denied is that every year European designs and articles are being imported into India in increasing numbers, and that apparently India unaided cannot or does not wish to stop this invasion. It is true that Mr. Havell has denied *in toto* that the ancient craft work of India is exhibiting symptoms of decay, though I cannot see how this denial can be reconciled with his admission that it is being ruined by European influence. With art as with life it has always been a battle for the survival of the more vigorous, and if Indian art still possesses its ancient vitality, it may well be asked how it comes to pass that the art of Europe is able to influence that of India at all. A similar struggle was seen in the Middle Ages in Europe when the tide of the Italian Renaissance swept away the Gothic art in England and France. In our own time, in a lesser degree, we have seen the great influence the art of Japan has had upon the art of Europe, but can it be contended that the art of India has exercised any similar or appreciable influence upon Western art at any period since the two came into contact? On the contrary, it requires even a less period than I have spent in the country to convince an unbiassed observer that from the day India ceased to be isolated the art of the West has increasingly influenced and modified that of India. If, as Mr. Havell holds, Indian art is full of vitality, it will fight its battle without any outside assistance; but if, as I, with other speakers contend, it requires careful guidance during this period of transition, then it seems to me that the apparently longer road of taking the designers and craftsmen back to the first principles of their art, and once more rebuilding, will in reality be both the shortest and surest way to infuse new vigour into Indian art which will make it proof against any alien influence. As I have said, the end we all have in view, and our aspirations, are the same, but our ways of attaining them differ. These aspirations and the theories we weave round them are fascinating in themselves, and are valuable for the purpose of focussing attention on

the subject. They may be indulged in freely when the theorist is six thousand miles away from India, and free from the responsibility of guiding the future careers of five hundred art students. It is when the question of training these five hundred students into citizens, each of whom shall be able to live by his work, and become a useful member of the community, has to be practically dealt with, that one's theories are so often found to fail to fit in with the conditions of the moment. I cannot agree with Mr. Havell that the keynote of my remarks is contained in the sentence "that although the artistic capacity of the Indian people is still present, the ancient craftwork of India is as dead as that of the Greeks, or that of the Renaissance in Europe." I should say that the keynote of my paper is that we have, in the past, attempted to carry out our theories of what Indian art might be regardless of the changed conditions of the country, instead of making those conditions the basis of our theories. If it were made an indictable offence to introduce into India any article of European design, I agree that the problem of preserving Indian art from European influence would be much simplified; but is there a theorist amongst us who would venture to propose so drastic a remedy? Unless we are prepared to do something very like this, we must accept the conditions as they are, and strive to our utmost to make the best artistic use of them. So far from being obsessed by the idea of teaching the craftsmen of India to manufacture his handicraft work in imitation of Europe and America, I can assure Sir George Birdwood that my mind is obsessed by the idea of training young India to develop her innate capacity in order to be independent of the West. With him and Mr. Havell, I regret the change in the conditions under which the craftsmen of India now have to work, and were it within my power would gladly assist them in banishing European art from India forthwith, but as the power to do that is absent, it appears to me that as a practical servant of the country the only thing to do is, as I have said, to make the best artistic use of the conditions as we find them, without wasting breath in railing at them, and to keep steadily before one's mind the fact that although it may not be within the power of any School of Art to produce, at call, a genius, it is possible to impart to all students sound principles in design, and to make them thorough and expert craftsmen, and so arm them for the battle of life and train them to become useful citizens. Thus equipped, I have complete faith in the power of the people of India again to take the high place they formerly held in the world of art, and to make that place a reflection of Indian ideals and character.

In continuation of the remarks which he made at the meeting Mr. CHATTERTON writes:—

It is a matter of regret there was not time to discuss adequately the very valuable practical paper which Mr. Burns read. It dealt with matters of live interest to the people of India and was an important contribution to the discussion which has been going on for a long time regarding the indigenous industries of India and what steps should be taken to enable the handiworkers to recover their local position or to tide over the period of transition in industrial matters through which India seems to be passing. This again is one phase of the great question which occupies the attention of everyone concerned in the administration of India at the present time—the development of the material resources of the country was to provide suitable employment for the ever-increasing number of those who have received a modern education, and what was perhaps even most important to mitigate the severity of the frequently recurring labour famines due to the dependence of too large a proportion of the population upon agricultural pursuits for a means of livelihood. The right course to pursue is to encourage industrial development in every possible way and by every legitimate means. New industries must be started, and the existing indigenous industries organised to meet the changed conditions of modern times. The resources of science must be placed at the disposal of the people of India and facilities provided for technical education and technical investigations. The more general diffusion of elementary education is essentially a preliminary step, and in this direction I am glad to say a great deal is now being done. The artisans of India are very ignorant, very superstitious, and intensely conservative, yet they are not altogether devoid of enterprise, and much could be done if they were supplied with capable leaders and definite lines were laid down as to the policy which should be adopted to bring about an improvement in their material condition. Of necessity this must be the work of Government, and in Madras a special department has recently been created to deal with industrial questions. Mr. Burns realised that something similar was required in Bombay, and the establishment of a technical laboratory in Bombay to inquire into and improve the processes employed by potters, weavers, calico printers, metal workers, and cabinet makers is apparently the initial effort in that direction. It is questionable, however, whether the School of Art is the proper institution in which to carry on such work, and I think that in Bombay, as was the case in Madras, it would rapidly grow beyond the means of control of the Education Department, and would become sufficiently important to need a new department to carry on the work and develop it. Something more than mere industrial schools for the training of boys is necessary. The younger artisans must be provided for and their training can only be satisfactorily effected in workshops where methods and processes are carried on under the conditions which must prevail in factories. I think Mr. Burns is very far from accurate in stating that "all attempts that have hitherto been made to mix up business with teaching in the Schools of Art in India have proved either educational or business

failures." I hope I am not claiming too much for Madras when I state that in this direction they are in advance of the rest of India and have already obtained results which promise well for the future and give them the assurance that they are working on the right lines. The difficulties no doubt are great, but they have been overcome, and under the superintendence of properly qualified men I think industrial development and industrial education can well be carried on conjointly. The slender resources of the State and the lack of organisation in native industries preclude the following of European methods, and it is better to work an admittedly imperfect system that is practicable than talk about a more perfect system for the carrying out of which adequate funds cannot be provided. It is obviously impossible on the present occasion to discuss this issue thoroughly, and I only allude to it to indicate that a great deal more has been done in other parts of India than Mr. Burns seems to be aware of. Dealing with the paper generally, I think that Mr. Burns has presented an accurate account of the state of Bombay art industries as applicable to all India. It certainly is not so especially in respect to Madras, where there have been other influences at work to counteract the baneful effect of Western civilisation on the artistic handicrafts of the Presidency. I would particularly like to draw attention to the work of restoring the temples of Southern India to even more than than their pristine splendour, which has been taken up and carried on for many years past by the Nattuscottar Chetties of Madras—a work on which they have spent enormous sums of money, and kept in continuous employment a large number of the most skilful hereditary art craftsmen of the Presidency. It was done in a very unostentatious way, and very few people knew anything about it, but a visit to some of these temples would convince anyone that the Indian artisan has not yet lost his cunning, and that, placed in a suitable environment, he is still capable of planning as great works and bestowing upon them the same careful attention to detail as his forefathers did, when the land was still under the sway of the Dravidian princes and polygars.

Colonel T. H. Hendley, C.I.E. (President of the Art Conference in Lahore) writes :—

I am glad that Sir George Birdwood and other speakers do not share Mr. Burns's depressing view that the Indian craftsman is living on a dead past; the power is still there, but, as Mr. Lewis Day has said, it is only dormant. For the moment it seems to me that it has been submerged by too violent contact with the West, by the rapid communications of the age, and by the injudicious and often ignorant patronage of a wealthy, but, from an art point of view, uneducated public. I have always hoped and believed that the chief purpose of Schools of Art in India was to stand between the indigenous craftsmen and all these disturbing influences, by encouraging and helping them. Such aid can be afforded in many ways; for instance, by greater care in selection of materials, with more attention to accuracy and finish in workmanship, and by very slight modifications, Indian productions might be made commercially more profitable, without injury to their importance as examples of Oriental art. I am pleased that Mr. Burns recognises the good work which was done in the past by my friends, Messrs. Kipling and Griffiths, and the more so, because the influence such men exerted is sometimes under-estimated. It has also been the fashion at times, as I think somewhat unjustly, to look upon official authorities as always unsympathetic. It is true, as Mr. Burns has told us, that proposals have been made to abolish Indian Schools of Art, or to convert them into technical schools; but on mature consideration they were preserved. In 1893, the Secretary of State even went so far as to state that "there was a general consent that they served no really useful purpose." This led not only to a careful enquiry into the matter by the experts who were present at the Second Decennial Art Conference, which was held at Lahore in January, 1894, but to an invitation to the local Governments in India to express their opinions. In the report of the Conference it was urged that the schools had been most useful in many ways which time will not allow me to mention in detail now. It was held, moreover, that they had had a most beneficial effect in protecting the arts and artisans of the country from the extraneous and dangerous influences to which the conditions of modern life and the facilities of interchange of ideas had subjected them. The members of the Conference thought that the true principles of art, and especially of Oriental art, which had been taught in the schools, had been most valuable in retarding the decay of Indian art. I need not, however, quote further from the report, because, in the main, the views of the Conference were approved by the Government of India, and were finally accepted by the Secretary of State, and thus the schools were preserved and have continued to do good work. Further, as Mr. Burns has proved to us, by the account of his own experience and judicious management, they are still bringing the knowledge and practical methods of the West to the aid of the hereditary skill and aptitude of the East; but I am particularly pleased to hear that he looks for ultimate success, as we members of the Conference did, to the inculcation of the true principles of art, and especially of Oriental art, rather than to teaching a slavish imitation of the past and adherence to its traditions. In the Secretary of State's despatch to which I have referred, it was observed that "great and ever-increasing difficulty is found in securing the services of European teachers fit to be entrusted with the direction of such schools (of art) in India." So far we have evidence to-day that such men can still be found, but if they are to be trained in institutions arranged on the basis of materials, as is now threatened, it will be doubtful if they will be

forthcoming in the future. I regret that Mr. Burns finds that there is still such a strong tendency to use European decoration in Indian buildings. There seems to me to be no general need for this, although we must not be altogether out of sympathy with the inclination of many wealthy Indians to prefer Western designs and fashions, especially when they happen to be more suitable as they think or more comfortable and convenient than their own. A word may be said even for the objectionable corrugated iron. The late Maharaja of Jeypore, when someone remonstrated with him for allowing verandahs of this unsightly material to be attached to the walls of his marble palaces, said that, at least, they were more useful and economical than the striped curtains which they replaced, which indeed only looked well when they were new. Moreover, the Bengali, who roofs his shops and huts in his villages with such iron, has some right on his side when he urges that it is less liable to burn than the picturesque thatch which it replaces. Such are some of the difficulties with which the schools have to contend, but difficulties can be overcome. Thus I might airly notice how the Indian craftsman can still hold his own and be employed with success. I think, I am right in stating that his services have been used almost without exception in decorating the numerous buildings which have been designed by Sir S. Jacob, and I believe by other architects, in Rajputana. In the Jeypore Museum, for example, the beautiful carved work in marble is all purely Indian. Much of it was no doubt reproduced from old Indian designs, but a good deal is new, though it was designed in the spirit of the past. I am reminded particularly of how each individual craftsman was allowed to model in clay a capital and a base of a column for one of the arcades of the museum, which, if approved, he was permitted to execute in stone and to carve his name upon his work. This was not slavish imitation but real living and progressive art, and I firmly believe that if encouraged there will be found in most parts of India craftsmen who are capable of doing similar work; but it is mainly to the Schools of Art with such superintendents as Mr. Burns, and to such sympathetic architects as Sir S. Jacob, that we must look for the wise guidance and assistance to which I refer.

THE LORD CHIEF JUSTICE ON THE PATENTS ACT.

The Lord Chief Justice, in opening the proceedings of the "Law, Political Economy, and Legislation Affecting Chemical Industry" Section of the International Congress of Applied Chemistry, at South Kensington, said that in choosing his remarks he naturally gravitated towards the subject of which he had most experience—the right method of legislating upon and dealing with scientific knowledge. He wished to approach the subject from the broadest possible standpoint, and to consider the principl upon which legislation should proceed, not in thi country alone, but in all civilised countries. He di not believe there ought to be different rules i different countries, but as far as possible they ougl to see whether in the British Empire, France, Ger many, the United States, and other great countrie they could not approximate to an international cod in connection with the proper protection of inven tions. It was from that point of view he wished t consider a step which had recently been taken i Great Britain, a step which, to a certain exten followed the example of some other nations wit regard to the making it a condition that a pate should be worked in the country in which it had bee taken out. In his opinion that was a step in th wrong direction which would discourage inventor and which would make people revert to secr processes, one of the worst forms by whic inventions could be developed. Further, it w hard upon the genuine inventor, who was oft a very bad man of business indeed. He h always maintained that view. He would take kindred illustration—the enactment adopted in En land, against his express wish, destroying provision specifications. Let them protect the investor much as they liked, but let them not do anything destroy public knowledge. Take the case of t scientific men, many of whom had the power of inve tion and were always thinking of something ne but who often were wholly unfitted to work out t inventions themselves. The real advantage to t public in those circumstances lay in other peop taking up the invention and working it. At prese the working of a patent was compulsory, and application might be made to revoke the patent ev in the country in which the patentee resided, a that appeared to be driving an idea to an exce He knew there was a strong impression—he was n the least in favour of it from the Protectionist poi of view—that by this means they would then devel the industry of the particular country. It seemed him that if they were to lay down this test abo working they would meet with many difficulties, f the conditions were different in dealing with chemic products and with general manufactures, and wi subordinate parts in an old machine and an entire new machine. They were approaching the subject fr the wrong standpoint. He wanted in the first pla to protect the inventor so that the product of h invention would be used with advantage to hims and with the largest advantage to the public. they desired to interfere with the monopoly rights a patentee, the proper view to take was that the should be freedom of working on a fair licence, if t patentee did not sufficiently work the patent himsel Under those conditions the difficulties about injun tions would to a large extent disappear. If a patente were a dog-in-the-manger, and would not allow patent to be worked except on prohibitive terms, l all means have an independent tribunal which shoul

ay on what conditions and on what terms the patent ought to be worked. But if they allowed people who really wished to work that patent to do so on fair terms under licence, they need not put on the patentee the burden of working it when he did not wish to do so. There were numbers of illustrations which showed that compulsory working would not be a real remedy for the evil, and would at the same time impose upon many patentees a very great burden. The inventor should be given a fair and not an excessive reward for his invention, and should be freed from those commercial difficulties which had embarassed so many men. If there were a capitalist, a merchant, or a manufacturer who felt he could make good public use of a patent, let him work it on terms fair to the patentee, but do not let them say that a patent was to be revoked because the patentee was not able to work it. He hoped it was not too late to suggest from an international point of view that patents should be worked by those desirous of working them on fair royalties, paid to the patentee. There ought to be international recognition of invention and discovery. There was no class of invention to which the observations he had made applied more strongly than that of chemical industry. It seemed to him that knowledge was the birthright of no particular nation, but ought to be shared by the whole human race. There ought to be no temptation to bottle up or keep secret the discoveries of scientific men or the results of their labours. The perfect system would be to give every inventor a fair and full—might he say a generous ?—reward for his invention, and relieve him in many cases of the anxiety of developing it, so that he might be free to pursue his studies for the benefit of mankind, and to investigate the inexhaustible fields of knowledge yet unexplored.

COMMERCIAL DEVELOPMENTS AT NAPLES.

The recent visit of the King and Queen to Naples lends interest to the last commercial report emanating from the British Consul-General at that port, which has just been issued from the Foreign Office. Unfortunately, 1908 was a gloomy twelvemonth, owing to a drought such as had not been known in South Italy within the memory of man, while the terrible disaster of the Messina earthquake occurred just three days before the close of the year. The crops which failed largely were the corn crop, including maize, the green crops, including hemp, flax, lucerne, and beans, and the oil crop. The only abundant yield was that of the vine, and this followed on the productive season of 1907, so that it is hardly surprising, in the congested state of the market, to hear that people have been talking about replacing the cultivation of the vine by cotton or tobacco. It is satisfactory to find the United Kingdom at the head of the list of the chief importing countries, though, in respect of exports from Italy to foreign countries, we actually stand at the bottom of the list. England's chief import is coal, most of which goes to Genoa. In order to encourage trade generally between Italy and the United Kingdom, an agreement has been arrived at to admit free from every duty patterns and models with which it may be intended to procure orders, and which are *bonâ fide* not for sale. British commercial travellers in Italy and Italian commercial travellers in the United Kingdom may accordingly enjoy this privilege, subject only to certain easy formalities, intended to guarantee the re-exportation of the articles when done with, or their introduction into bond. From a British-Indian point of view, it is interesting to see that during the year a company has commenced the manufacture of jute textiles, the raw material being imported from Calcutta. The accommodation at the port of Naples, for landing both passengers and goods, is lamentably deficient, the state of things as regards the latter being a grievance specially affecting British trade, owing to the quantity of grain carried in British bottoms. Another matter touching our shipping interests, is that the Italian lines of steamship companies are taking away, year by year, more of the emigration traffic from the foreign lines. They have already more than half of the whole traffic, while there is a Bill before the Italian Parliament which, if passed, will make it still more difficult for foreign lines to continue carrying emigrants.

Probably, however, the most interesting matter mentioned in the report relates to a pending undertaking in the neighbourhood of Baia and Pozzuoli, two localities recently visited by King Edward and Queen Alexandra. Here, we are informed, it is proposed to revive a project partially carried out by King Bomba some sixty years ago. The new work is to consist of a navigable canal about three-quarters of a mile in length, to be dug from the excellent anchorage of the Gulf of Baia to the lake of Avernus, the well-known classical basin, which occupies the site of an ancient crater and was popularly supposed by the Romans to be the entrance to the infernal regions. It is very deep and the proposal is to construct there docks and shipbuilding yards. A quay was actually built round the lake by the King of Naples some sixty years ago, and a small canal was also excavated as far as the sea, but the cost of completing the undertaking proved to be too great, and further operations were abandoned. For the present project capital has, it is said, been supplied from Belgium. But the most notable circumstance, not mentioned in the Consular report, is that the whole scheme would appear to be a restoration of an important work which was planned and carried out by Agrippa, Octavianus' great scientific general, in the century just before the Christian era. Even in those days the depth and proximity to the sea of Lake Avernus* seems to have attracted the

* The depth and steep sides of the former craters are mentioned by Vergil in the well known lines:—

Facilis descensus Averno,
Sed revocare gradum, superasque evadere ad auras,
Hoc opus, hic labor est!

notice of engineers, and when the coasts of Italy were being ravaged by the fleets of the younger Pompey, Agrippa, a born engineer and geographer, conceived the plan of organising a navy capable of coping with that of his foe. He united the Lucrine lake with the sea, and joined the former with Avernus. In this sheltered port named Portus Julius, the fleet was built and equipped, and 20,000 manumitted slaves were trained in rowing and naval manœuvres till able to cope with the seamen of Pompeius, who were defeated successively at Mylæ and Naulochus. The subsequent great victory of Agrippa over the fleets of Antony and Cleopatra at Actium, an event which made Augustus emperor of the world, may be said to be a further fruit of his naval policy, as evolved by this remarkable work. How the harbour fell into disuse is not precisely known, but there may have been even in classical times a gradual upheaval of the Lucrine Lake, which made access from the sea an impossibility. In 1631 there was a great eruption of Vesuvius, which had been quiescent for 492 years, and a hill, several hundred feet in height and about three miles in circumference, suddenly arose in a single night from the bottom of the Lucrine Lake. It was appropriately called Monte Nuovo, which name it still bears. The circumstances are picturesquely narrated by Sir William Hamilton, the well-known British ambassador at Naples in 1776, and friend of Nelson, who devoted several years to the most careful investigation of volcanic phenomena.

THE PRODUCTION OF BRIQUETTES.

Only fifty years ago the dust of coal was considered to be entirely useless, but since then a great change has taken place, and at present in Rhenish Westphalia the Ruhr coal district alone produces 3,000,000 tons of briquettes each year, according to the United States Consul at Barmen, who in a recent report has furnished some interesting details regarding the advantages of the use of sulphite pitch, with a preliminary statement concerning the making of coal briquettes with tar pitch in general. Up to the present time coal tar pitch has been used for making coal briquettes, and its production in the past ten years has increased about 100 per cent. Most of the coal tar pitch is produced in England and Germany, the latter country only being able to produce for its own consumption, while England supplies the remaining customers, *i.e.*, America, Russia, and Belgium. The coal tar pitch is an excellent binding agent for baking and coking coal, especially bituminous. It burns easily, and gives the briquettes hardness for long distance transport, but various qualities of good material cannot be turned into briquettes with it, thus making its common availability impossible. Its numerous disadvantages are as follows :—It produces very much smoke, and has a very disagreeable odour ; it cannot stand a high temperature, and becomes soft and difficult to use in hot weather : the dust and fumes of coal tar being corrosive, are very injurious to the skin, eyes, and lungs of the workmen employed, causing diseases of those organs. The low temperature at which it ignites, although an advantage when used with soft bituminous coal, becomes a great disadvantage when the attempt is made to use materials that burn less easily. The coal tar becomes soft and burns much more rapidly than the coal flowing out of the briquette, leaving the coal to fall to pieces in dust and remaining unconsumed. For this reason it has been impossible to use in the making of briquettes, anthracite, semi-anthracite, or coke gravel with coal tar pitch, it being unable to resist the heat and pressure of the blast furnace; therefore a binding agent which overcomes all of the difficulties mentioned, and is capable of making use of these materials in the production of briquettes, which up to the present time have been lost, ought to have good results for the future. This long-sought-for binding agent is said to have been found in the "sulphite pitch." The material is obtained in the process of manufacturing sulphite cellulose. The wood is put through a washing process in lye, by which the fibre is cleared of all resinous ingredients, it being pressed out from the wood pulp. Thus far, according to the American Consul, the material has been entirely useless, but, through a cooking process, it is reduced to a highly glutinous substance called "sulphite pitch." The sulphite pitch possesses many qualities which show its excellent advantages as a binding agent. It is intensely glutinous and possesses a high binding power. In the ordinary briquettes of bituminous coal, from 7 to 10 per cent. of coal tar is used, to give it the proper hardness, and with the use of sulphite pitch the same results can be obtained by the use of 5 per cent. There are qualities of coal and ore that can easily be used in making briquettes with from 2 to 3 per cent. of the sulphite pitch. Sulphite pitch burns without smoke or smell, and is said to be an ideal fuel for the household as well as for industrial purposes. In cities where the smoke nuisance has hitherto prevailed, the use of briquette pitch may form a solution of the smoke question. Trials have already been made with coke briquettes made with this new process, in blast furnaces, and on torpedo boats. The former tests, according to the Consul, not only showed a saving of 30 per cent. coal, but the iron was almost entirely free from sulphur. In its trial on the torpedo boat it not only proved a perfect fuel, but the entire absence of smoke proved its advantage over other fuels in time of war.' Sulphite pitch does not soften under heat, and burns at a high temperature. It can be ground to any consistency, ... produced directly in any form of powder ; ... can be obtained in any country where there are cellulose mills, and it is very cheap, unlike the coal tar pitch, which is not so cheap. In general sulphite pitch consists of the following substances: Coke, 25 to 35 per cent. ; volatile matter, 50 to

per cent.; ashes, 8 to 12 per cent.; and water, 10 to 15 per cent. The latest chemical tests have proved that the percentage of ashes can be materially reduced. Through the origin of sulphite pitch, its ashes contain sulphur up to 20 per cent., or 2·5 per cent. of the sulphite pitch. One of the latest uses to which the sulphite briquette has been put, and in which it has proved successful, is as a dust layer for roads. Sulphite pitch was dissolved with water to a certain consistency and sprayed over the roads, and such a dressing was sufficient to prevent dust arising for at least six weeks. The production of sulphite pitch, as well as its use in the process of briquette making, call for special processes and machinery, which have taken years of costly experiment to develop successfully, and both the material and its use for briquette making are patented in all the principal countries. It is not supposed that sulphite pitch will in any way interfere with the coal tar pitch, in its use for the making of briquettes of soft bituminous coals, but the superiority of sulphite as a binding agent, rendering possible briquette making with the harder coals and cokes, and also with iron dust and other ores, opens up a new and very important industry. Already a large coke briquette factory has been built in Germany, at Luttringhaus, near Barmen, Elberfeld, and the entire output of the factory was sold out at once. Another large factory is in course of construction at Aix-la-Chapelle.

HOME INDUSTRIES.

Cotton Spinning Industry Accidents.—The annual report for 1908 of the Chief Inspector of Factories and Workshops refers to the frequent accidents from carding engines. Many are due to the hinged cover of the carding cylinder being left open for the process of "stripping" the cotton waste from the cards. In a short time further "strips" accumulate in front of the revolving cylinder and conceal it, and an operator who attempts to remove them under the impression that the cylinder has ceased to revolve, may have his hand crushed between it and the cover. Nor is the danger ended even when the belt is disconnected from the driving pulley, since the cylinder will often continue to revolve for a minute or two. The inspectors have accordingly pressed for the adoption of some locking device which will prevent the cover from being opened until the cylinder has come to rest, and will render it impossible to re-start the card until the cover has been closed. Another source of accident in the cotton spinning industry has been the practice of transferring the belt from the fast to the loose pulley (and *vice versâ*) by hand, and the inspectors have advised the provision and use of strap forks for the purpose. But this suggestion is opposed by operatives as well as employers; and, in order to expedite the general adoption of the necessary safeguards for carding cylinders, it was agreed, after prolonged negotiations with the Federation of Master Cotton Spinners' Associations, to allow the question of strap forks to remain open for the present, on condition that locking arrangements for the cards, conforming to the conditions mentioned above, are provided without delay.

Insurable Interest.—An important section of the Insurance Companies Bill now before Parliament relates to insurable interest, a question that has caused disquiet of late. The Bill lays it down that persons may have an insurable interest in the lives of their parents up to a reasonable amount, on account of funeral expenses, and the Bill is retrospective in so far that it provides that no policy already taken out shall be deemed void by reason only of the fact that the person effecting the policy had not at the time an insurable interest in the life of the person insured. It is very desirable that there should be legal sanction on what has been done for long as an economic necessity by a large portion of the community. If the Bill becomes law without substantial alteration, as it probably will, its effect is likely to be to strengthen the position of every sound society, and to discourage the formation of undesirable concerns. One of the most important provisions is that relating to deposits required by the Government. Not only are all companies transacting life assurance business to deposit £20,000, in respect of fire and accident insurance, and bond investment business, but companies beginning to transact any of these after the passing of the Act are required to deposit a similar amount, and the deposit is also required from all companies which have started employers' liability business since August 28th, 1907. It is to be regretted that the Government do not, apparently, see their way to make the clause retrospective in respect of all companies. At least they might be put on the footing of employers' liability companies, and be made retrospective as from August, 1907.

The Scottish Mineral Oil Companies.—Last year there was a fall in the prices of nearly all the products of the Scottish mineral oil companies, but notwithstanding, they were able to earn profits amounting in the aggregate to £380,200, as compared with £372,340 in 1907-8. All the companies have maintained the distribution on their ordinary shares, the Pumpherston Company paying 50 per cent., the Broxburn 17½ per cent., the Oakbank and Tarbrax 15 per cent. each, and Young's 7 per cent. This has been made possible by the fall in wages, and the cost of coal and the other commodities which the companies use in their process of manufacture. The shale miner's wages rise and fall with wages in the coal trade, so that a reduction in the price of fuel coincides with a fall in wages. The outlook for the current financial year is not quite so favourable, the companies having now to face keener competition in various directions. The Standard Oil Company has recently reduced the price of paraffin wax by ½d. per lb., and the Scottish producers have had to reduce

the prices of both wax and candles to a corresponding extent. Lubricating oils and naphtha are also likely to bring somewhat lower prices, owing to decreased demand, and keener competition has to be reckoned with in burning oil which, however, provides now only from 10 to 15 per cent. of the income of the companies. The price of sulphate of ammonia, now one of the most important products of the companies, is likely to be maintained owing to the increasing Continental demand for it as a fertiliser.

The Milk Bill and Dairy Farmers.—It is not surprising that at the annual conference of the British Dairy Farmers' Association held last week strong objection was taken to some of the provisions of the Milk and Dairies' Bill now before Parliament. Everyone must sympathise with the main object of the Bill which is to insure that the public get pure milk, but exception is taken to the power given to a medical officer of health to stop the whole of the milk of a farm if a sample of that milk contain a single microbe of the bacillus tuberculosis. Microbes are particularly difficult to identify in milk as a matter of ordinary microscopical examination. Yet on this slender evidence a dairy farmer might be caused great loss by the stoppage of the whole milk of his farm. It is not every medical officer who is capable of properly inspecting a herd, a truth apparently recognised by the framers of the Bill, which provides that when he inspects he must have a veterinary surgeon with him. The better way would seem to be to select a properly qualified veterinary inspector. It may be assumed that the clause relating to inspection to which such strong exception is taken by the dairy farmers will be amended.

Wheat Supplies.—There is little likelihood of wheat values falling away appreciably in the immediate future. The signs rather point to advance. The Continental demand is growing, and German requirements more especially are likely to be considerable. The German normal requirements of wheat are now about 27,000,000 quarters per annum, and the last crop was officially estimated at 17,270,000 quarters. The requirements from abroad would accordingly be nearly 10,000,000 quarters; but, assuming that the high price of wheat will check consumption, it is most probable that Germany will require 8,000,000 quarters of wheat from abroad. English requirements from abroad are also very considerable. On the other hand, the world's visible supply is unusually small. The American-Canadian is the smallest on record at this date. In the last two months the exports of wheat from America have been very trifling. Nor is it likely that the "invisible" supply is large, for if there was any considerable quantity of wheat in the United States available for export the present high prices would bring it forward. India is to some extent coming to the rescue by shipping wheat to Europe at the rate of about 200,000 quarters per week, and will probably continue to do so for some months to come, otherwise the price of wheat would be a good deal higher than it is.

Railways and Traders.—In the course of his remarks to a deputation of traders who waited upon him in December, 1906, Mr. Lloyd George, then President of the Board of Trade, stated that in Germany there was "no such thing as railway risk," and he went on to say that "German traders are very satisfied with the railway system, and consider that the railway system in that country is doing its very best to assist and to promote industries, and even to develop the weak industries." An appendix to the report of the Board of Trade Railway Conference, entitled "Report on Railways in Germany," does not support Mr. Lloyd George's opinion—at least, his opinion when President of the Board of Trade—that German railway conditions are much more favourable to the trader than British. Take, for example, the alleged absence of owners' risk. The report referred to above—prepared by Mr. Nicholas C. Reyntiens, barrister-at-law, and Mr. C. H. Pearson, of the Great Central Railway Company — shows that the practice of the German railways is to insist on such regulations in regard to packing as will "serve a most useful purpose in furtherance of the elimination of possible claims," while if the railway administration are not satisfied that the packing is sufficient to relieve them of any actual risk they refuse to convey the goods unless the consigner signs a paper expressly declaring that the goods are "unpacked," or "insufficiently packed," thus taking the risk on himself. Nor does the Report confirm the German statements made to Mr. Lloyd George as to German traders being "very satisfied" with railway management. The inadequate supply of wagons, especially at the season of the year when water transport fails, is the cause of constant complaint directed by the public against the railway administration. The Report also contains much information as to general railway conditions in Germany, from which it would seem that the administrative control is a much more complicated business than servants of State railways here are inclined to assume. The alleged simplicity of the system of railway rates in Germany is not made out, since "the catalogue of rate-books in existence shows that there are approximating to 1,000 different published books of rates." Railway rates in Germany are purely station to station rates, to which must be added the cartage charges of the "spediteurs," who also play an important *rôle* as forwarding agents. "The many complications of the tariffs," says the report, "require expert knowledge, which can only be obtained by constant practice." As to competition, from a public point of view, in so far as it may be said to be a benefit to trade, it is practically non-existent in Germany. As between the State and private lines, competition is "effectually stifled by the various methods of control."

QUESTIONS AND ANSWERS.

Readers in search of information which cannot be obtained from the usual sources are invited to make their wants known in the *Journal*, in the hope that they may be assisted in their difficulties by their fellow members.

On all communications must be written the name and address of the sender, not necessarily for publication, but as a guarantee of good faith.

Each question or reply should be written on a separate sheet of paper, and should bear such signature of the writer, and such address as he wishes to appear.

Questions which can be answered from the usual books of reference, will not be printed.

QUESTIONS.

STAINED GLASS WINDOWS.—I am obliged to N. H. for his reply to my question. But the point that puzzles me is, why for centuries we get only a brownish purple in stained glass, such as manganese (naturally containing more or less iron) would give, and then suddenly a rich violet purple. Is it implied that the substitution of soda for potash as a basic material would account for the colour? If, as N. H. says, "the peculiar properties of the cobalt ores of Saxony were only recognised about the end of the fifteenth century"—the mixture of cobalt with manganese would explain it all. But one had always taken it for granted that the sapphire blue of early glass was due to cobalt. If it was not cobalt, what was it, or what could it have been?—L. F. D.

ANSWERS.

EMBANKMENTS OF THE RIVER THAMES (see p. 343).—The question asked by "Londiniensis" is not easy to answer on account of the difference of opinion expressed by writers on the subject. As East London could not well have come into existence without these embankments, the general opinion is that they were formed either before the Roman occupation or immediately after that event. There are, however, others who do not date them before the Middle Ages. Probably the walls were formed at the earlier date, but were rebuilt at different times. The earliest recorded breach in the Essex wall took place in 1376, when great damage was done. The lands belonging to the Abbey of Barking were inundated and the resources of the Abbey were greatly crippled for many years by reason of the necessary outlay for the repair of the breach. There is now an inlet of the Thames above 1½ miles in length, with an area of nearly 60 acres, originally known as Dagenham Breach, and now as Dagenham Lake. This came into existence owing to a storm on December 17th, 1707, when a breach was made 400 feet long, and above 1,000 acres of land were inundated. Captain Perry succeeded in restoring the embankment, and drained the land, except the portion known as Dagenham Lake. This water is full of fish, and has the distinction of being the place where the old Ministerial fish dinners were instituted. There was a breach in the Kent wall in 1527 at Abbey Wood, and we hear again of "drowned lands" in 1563.

The late Sir George Airy, Astronomer-Royal, in a valuable article in the *Athenæum* (Jan. 28, 1870) on the Claudian Invasion of Britain, says that the walls were not constructed at that period. There are several references to the wall in early volumes of the Transactions of the Institution of Civil Engineers, but writers on London have been very neglectful in omitting all mention of these important works. The late Sir Walter Besant, however, is an exception, and in his work on *East London* (1901) he has an interesting chapter on "The Wall." He does not give so much information as might be wished, but he describes clearly what he observed in a walk on the wall from Barking, which he says is "the most curious walk that one may find within the four seas that encompass our island." "The wall," he adds, "is about fifteen feet high; at the base it is perhaps thirty feet wide; the sides slope towards the path at the top, which is about seven feet across; the outside is faced with stone, the inside turfed. . . . . On the land side lie the fields which have been rescued from this tidal flow; they are obviously below the level of the river; one understands, looking across them, how the river ran of old over these flats, making vast lagoons at high tide. It is useful to see the fact recorded in a book or on a map; but here one sees that it really must have been so." A full account of all that is known of these embankments would be of great value and abiding interest, but I do not know of the existence of any book devoted specially to this subject.—H. B. WHEATLEY.

FIRE WALKING (see p. 466).—Referring to "Maori's" question, in the *Journal* of April 23rd, I have with my own eyes seen a whole family walking on red hot ashes (coals) without any injury in the least being sustained. The family consists of men, women, and children, who walk once in every year, before a big audience, on fire. The ceremony takes place in about the month of January. Besides this, a month ago, a Mohammedan sayad had walked on fire, before a very big audience of gentlemen and leading citizens, and also in the presence of H.H. the Maharaja Saheb Gaekwar of Baroda. If "Maori" desires to see this personally, he may come over here when the time arrives, so that he will be able to see the scene with his own eyes. I may mention that the said sayad is not of this city but is a tourist.—RANEHHODDAL VORA, Baroda, India.

CATTLE FOOD FROM WOOD CELLULOSE (see p. 624).—A company was recently formed to work a foreign patent for extracting alcohol from sawdust. After the sawdust has been treated for this purpose it is mixed with molasses, and sold for cattle food.—W.

GENERAL NOTES.

FERRO-CONCRETE BRIDGE IN BURMA.—In a paper read recently before the Society of Engineers, Mr. W. E. Haldwell described the methods adopted in constructing a reinforced concrete arch bridge over a bridle road in a mountainous tract of country in Upper Burma. This, the Sinlumkaba Mill Bridge, is the first reinforced concrete bridge to be erected in that country. The bridge was constructed by the Burma Public Works Department, and is in one span of 40 ft., with a rise of 12 ft. in the arch, the entire width of the bridge being 9 ft., and the width of roadway inside parapets 6 ft. The level of the crown of the arch is 8 ft. above the highest known flood level. The entire arching was made of cement concrete, with two layers of reinforcing bars, the bottom layer being placed 1½ in. above the intrados, and the top layer 1½ in. below the extrados of the arch. The longitudinal reinforcing bars were placed 9 in. apart, with cross bars at right angles to them, at intervals of 2 ft., both longitudinal and cross bars (which were all ½ in. thick), being wired together at their intersections with $\frac{1}{16}$ in. wire. The thickness of the arch at the crown was 10 in., and at the haunches 3 ft. 9 in. Thus the distance between the two layers of reinforcement was 7 in. at the crown and 3 ft. 6 in. at the haunches. The backing of the bridge was formed by parallel spandrel walls, made of coursed rubble masonry in lime mortar, 4 ft. wide at the bottom and 2 ft. in width at the crown level of the arch. At this level a masonry wall 1 ft. 6 in. in thickness was built along either side of the arch for a height of 1 ft., thus acting as a retaining wall for the filling in over the crown, and on this wall the masonry parapet pillars of the bridge were built and connected by ⅞ in. square iron bars, which formed the railing.

OLD-AGE PENSIONS IN NEW ZEALAND.—Mr. Pember Reeves, late Agent-General for New Zealand, has given some interesting facts in relation to the working of the Old-Age Pensions Law in New Zealand. That law has now been in operation for a little more than a decade. Based more or less upon the Danish law, it has itself served as a model for the pension laws of the Australian Commonwealth, and to a large extent for the British Act of last year. It exacts no contributions, but grants free pensions to such of the aged poor of New Zealand as are not flagrantly undeserving. The maximum pension granted is ten shillings a week, and the age limit 65. To attain the pension the applicant has to comply with a number of stipulations, chiefly relating to nationality, good character, income, and property. As compared with the English law, that of New Zealand appears almost lavish in its offers. Instead of a maximum pension of 5s. after the age of 70, it holds out a possible pension of 10s. weekly after the age of 65. The Maori is eligible but not the Asiatic. Women are eligible whether married or single. Comparative poverty and a measure of respectability are the main qualifications. The average private income of the pensioners outside of their pensions is £8, and numbering 13,000 they possess between them private property amounting to something like half a million sterling. A pensioner may earn or receive as much as £34 yearly without being disqualified for a full pension. As the full pension is £26 a year this means that the State is ready to make a man's income up to £60. Above that deductions begin. A man with a private income of £59 a year is entitled to £1 pension only. A married couple when both are entitled to the full pension may therefore draw £1 a week between them. Five years' imprisonment for any disgraceful offence disqualifies the convict for twenty-five years, four convictions for minor but discreditable offences also disqualify though for a shorter term. Wife desertion and habitual drunkenness disqualify, but positive proof of an industrious life is not required. On the other hand, an applicant, if he would succeed, must be supported by the testimony of some person of good standing who has known him for a long time, and the authorities must be satisfied that for at least five years before making his claim he has led a sober and respectable life. The number of pensioners in New Zealand at 65 years of age, and qualified for pension, is about 40,000, the number of actual pensions about 13,000. The effect of the tests as to income, property, and character is thus apparent, the number of pensioners being but 32 per cent. of the whole of the aged class. Mr. Reeves estimates that the cost of the Act this year will probably reach £350,000, a considerable sum for so small a population, but scarcely a voice is raised against it. The expenses of administration amount to no more than 1·69 per cent. of the total cost since inception, and are entirely the affair of the Central Government.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 21...Victoria Institute (at the HOUSE OF THE ROYAL SOCIETY OF ARTS, John-street, Adelphi W.C.), 4 p.m. Presidential Address by the Earl of Halsbury.

FRIDAY, JUNE 25...Physical, Imperial College of Science South Kensington, S.W., 5 p.m. 1. Professor Carhart, "A Transition Point in Zinc Amalgam." 2. Dr. T. M. Lowry, "A Method of Producing an Intense Cadmium Spectrum, with a proposal for the use of Mercury and Cadmium as Standards in Refractometry." 3. Mr. A. Campbell, "The Measurement of Wave-length for high frequenc[illegible] Electrical Oscillations." 4. Dr. A. Russell and Mr. J. N. Alty, "An Electro-magnetic method of Studying the Theory of and Solving Algebraica[illegible] Equations of any Degree." 5. Mr. S. D. Chalmers "The Sine Condition in relation to the Coma of Optical Systems." 6. Dr. C. V. Drysdale, "Exhibition of a new Fery Thermo-electric Calori[illegible]meter." 7. Mr. F. W. Jordan, "An Instrument for Measuring the Strength of an Intense Horizontal Magnetic Field." 8. Professor Poynting and Mr. G. W. Todd, "A Method of Determining the Sensibility of a Balance." 9. Mr. G. W. Todd "The Balance as a Sensitive Barometer."

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FRIDAY, JUNE 25, 1909.

FINANCIAL STATEMENT.

The following statement is published in this week's *Journal* in accordance with Sec. 40 of the Society's By-laws:—

TREASURERS' STATEMENT OF RECEIPTS AND PAYMENTS FOR THE YEAR ENDING MAY 31ST, 1909.

Dr.

	£ s. d.	£ s. d.
To Cash in hands of Messrs. Coutts and Co., 31st May, 1908		2,308 13 0
,, Subscriptions	5,427 9 0	
,, Life compositions	504 0 0	
		5,931 0 0
,, Dividends and Interest		623 7 1
,, Ground Rents		649 15 0
,, Examination Fees		3,865 5 0
,, Conversazione, 1908 (sale of tickets)		49 10 0
,, Advertisements		433 13 9
,, Sales, &c.:—		
Cantor Lectures	21 6 11	
Examination Programmes	47 13 8	
Fees for use of meeting-rooms	44 2 0	
Journal	128 3 3	
		241 5 10
,, Donation to Examination Prize Fund:—		
Clothworkers' Company		30 0 0
,, Committee on Leather for Book-binding:—		
Sale of Reports		5 2 3
,, Francis Cobb Fund:—		
Received from Trustees		250 0 0
		£14,388 0 11

Cr.

	£ s. d.	£ s. d.
By House:—		
Rent, Rates, and Taxes	841 10 10	
Insurance, Gas, Coal, House expenses and charges incidental to meetings	313 5 1	
Repairs and Alterations	43 5 2	
		1,198 1 1
,, Office:—		
Salaries and wages	2,339 3 5	
Stationery, Office Printing and Lithography	503 14 11	
Advertising	70 2 0	
Postage Stamps, Messengers' Fares, and Parcels	306 10 2	
		3,219 10 6
,, Library, Bookbinding, &c.		98 14 8
,, Conversazione (1908)		313 4 8
,, *Journal*, including Printing and Publishing		2,046 15 2
,, Advertisements (Agents and Printing)		306 16 0
,, Examinations		3,673 1 10
,, Medals:—		
Albert	20 13 0	
Society's	39 3 5	
		59 16 5
,, Owen Jones Prizes		5 13 0
,, Swiney Prize		180 0 0
,, North London Exhibition Prizes		5 0 0
,, Mulready Trust		20 0 0
,, Aldred Trust		10 0 0
,, Juvenile Lectures		20 0 0
,, Stock Trust		20 0 0
,, Cantor Lectures		190 1 6
,, Shaw Trust		39 11 3
,, Sections:—		
Applied Art	50 0 0	
Colonial	45 18 2	
Indian	68 15 7	
		164 13 9
,, Committees (General Expenses)		17 8 1
,, Francis Cobb Fund:—		
Placed on Deposit		250 0 0
		11,838 7 11
,, Cash in hands of Messrs. Coutts and Co., May 31st, 1909		2,549 13 0
		£14,388 0 11

Liabilities.

	£ s. d.	£ s. d.
To Sundry Creditors	684 10 4	
,, Examiners' Fees	1,235 12 6	
,, Examination Prizes and Medals	230 0 0	
,, Sections :—Colonial and Indian	100 0 0	
,, Accumulations under Trusts	233 4 10	
		2,483 7 8
,, Excess of assets over liabilities		25,121 5 5
		£27,604 13 1

Assets.

	Amount of Stock, &c. £ s. d.	Worth on 31st May, 1909. £ s. d.	£ s. d.
By Society's Accumulated Funds invested as follows:			
Newcastle-on-Tyne 3½ per cent. stock	3,000 0 0	2,970 0 0	
Canada 3½ per Cent. Stock	500 0 0	507 10 0	
South Australia 4 per Cent. Stock	500 0 0	512 10 0	
N.S. Wales 3½ per Cent. Stock	530 10 1	530 10 1	
N.S. Wales 4 per Cent. Stock	500 0 0	540 0 0	
G. Indian Pen. Ry. 4 per Cent. Debenture Stock	217 0 0	238 14 0	
Queensland 4 per Cent. Bonds	1,500 0 0	1,552 10 0	
Natal 4 per Cent. Stock	500 0 0	537 10 0	
Ground Rents (amount invested)	10,496 2 9	10,496 2 9	
Metropolitan Water Board B. Stock	321 15 9	300 17 5	
New River Co. shares	6 0 0	6 0 0	
National War Loan	3,134 8 3	3,157 18 4	
	21,205 16 10		21,350 2 [illegible]
,, Subscriptions of the year uncollected		735 0 0	
,, Arrears, estimated as recoverable		275 0 0	
			1,010 0 0
,, Property of the Society (Books, Pictures, &c.)			2,000 0 [illegible]
,, Advertisements due			294 17 [illegible]
,, Cash in hands of Messrs. Coutts and Co., 31st May, 1909			2,549 1[illegible]
,, Do. on Deposit (against interest on Trusts)			400 0 [illegible]
			£27,604 1[illegible]

Funds held in Trust by the Society.

	£ s. d.	
Dr. Swiney's Bequest	£4,477 10 0	Ground-rents, chargeable with a sum of £200 once in five years
John Stock Trust	100 0 0	Consols, chargeable with the Award of a Medal.
Benjamin Shaw Trust for Industrial Hygiene	133 6 8	,, ,, ,, of Interest as a Money Prize
North London Exhibition Trust	192 2 1	,, ,, ,, ,,
Fothergill Trust	388 1 4	,, ,, ,, of a Medal.
J. Murray and others, in aid of a Building Fund	75 14 4	,, £54 18s. od. and National War Loan £20 16s. 4d.
Subscriptions to an Endowment Fund	562 2 2	,,
Dr. Aldred's Bequest	220 2 3	,, chargeable with the Award of a Prize.
Thomas Howard's Bequest	571 0 0	Metropolitan Railway 3½ per Cent. Preference Stock, chargeable with the Award of a Prize for an Essay.
Dr. Cantor's Bequest	648 19 7	Bombay and Baroda Railway Guaranteed 3 per cent. Stock — Interest applied to the Cantor Lectures.
	3,273 16 6	India 3 per cent. Stock — Interest applied to the Cantor Lectures.
	2,695 11 3	Ground-rents — Interest applied to the Cantor Lectures.
Owen Jones Memorial Trust	423 0 0	Canada 4 per Cent. Stock, chargeable with the Award of Prizes to Art Students.
Mulready Trust	105 16 0	South Australia 4 per Cent. Stock, the Interest to be applied to keeping Monument in repair and occasional Prizes to Art Students.
Alfred Davis's Bequest	1,953 0 0	Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock. Interest at the disposal of the Council for promoting the objects of the Society.
Francis Cobb Fund	250 0 0	On Deposit with Messrs. Coutts and Co.
Amount to cover accumulated Interest on Trust Funds	400 0 0	On Deposit with Messrs. Coutts and Co.
	£10,470 2 2	

Total of Investments, &c. (Face Value), Standing in the Name of the Society (including Society's accumulated Funds and Trusts as above).

Ground Rents (amount of cash invested)		£17,669 4 0
Consols		1,650 12 6
Metropolitan Railway 3½ per Cent. Preference Stock		571 0 0
Bombay and Baroda Railway Guaranteed 3 per cent. Stock		648 19 7
India 3 per cent. Stock		3,273 16 6
Canada 4 per Cent. Stock		423 0 0
Canada 3½ per Cent. Stock		500 0 0
South Australia 4 per Cent. Stock		605 16 0
New South Wales 3½ per Cent. Stock		530 10 1
New South Wales 4 per Cent. Stock		500 0 0
Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock		2,170 0 0
Queensland 4 per Cent. Bonds		1,500 0 0
Natal, 4 per Cent. Stock		500 0 0
Newcastle-on-Tyne 3½ per cent. Stock		3,000 0 0
Metropolitan Water Board B. Stock		321 15 9
New River Company Shares		6 0 0
National War Loan		3,155 4 7
Cash on Deposit with Messrs. Coutts and Co.		650 0 0
Society's Accumulated Funds	21,205 16 10	£37,675 19 0
Trust Funds held by Society	16,470 2 2	

The Assets, represented by Stock at the Bank of England, and Securities, Cash on Deposit, and Cash balance in hands of Messrs. Coutts and Co., as above set forth, have been duly verified.

Owen Roberts, John M. Thomson, } *Treasurers.*

H. T. Wood, *Secretary.*

Knox, Cropper & Co., *Auditors.*

Society's House, Adelphi, 22nd June, 1909.

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Fifty-fifth Annual General Meeting for the purpose of receiving the Council's Report and Treasurers' Statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held in accordance with the By-laws on Wednesday, 30th June, at 4 p.m.

(By Order of the Council),

Henry Trueman Wood,
Secretary.

CONVERSAZIONE.

The Society's Conversazione will be held, by permission of the Trustees of the British Museum, in the galleries of the Natural History Museum, South Kensington, on Tuesday evening, June 29th, from 9 p.m. to 12.

The Reception, by Sir William H. White, K.C B., F.R.S., Chairman, and the other Members of the Council, will be held in the Central Hall from 9 to 10 p.m.

A Selection of Music will be performed by the Band of H.M. Royal Engineers, in the Central Hall, commencing at 9 o'clock.

An Instrumental Concert by the "Red Band," under the direction of Mr. Thomas Batty, will be given in the Fish Gallery from 9.15 till 10.15 p.m., and from 10.30 till 11.30 p.m.

A Gramophone and Auxetophone Concert, under the direction of the Gramophone Company, will be given in the Shell Gallery at intervals from 9.15 p.m.

The following portions of the Museum will be open :—

The Central Hall, containing cases of specimens illustrating Mimicry; adaptation of colour to surrounding conditions; protective resemblance, &c.; also specimens illustrating the food of Fishes, and the life-history of the Eel (East of staircase).

The North Hall, containing the collection of Domesticated Animals.

The Bird Gallery, containing groups of

British Birds and Nests; and in the Pavilion, at the West end, an exhibition of the Land and Fresh-water Vertebrate Animals of the British Isles.

The Fish Gallery, containing the Great Basking Shark, the grotesque deep-sea fishes (case 44), the Tunny (case 38), the Tarpon and Angler-fish (case 27), the Lemon-sole (case 30), &c.

The Shell Gallery, including a life-size model of a Giant Squid (Newfoundland), and of a giant Octopus (California).

The East and West Corridors on the First Floor, containing the Okapi, African Antelopes, and Giraffes.

Light Refreshments will be supplied at Buffets in the North and South Corridors n the First Floor of the Museum.

Visitors travelling by District Railway (or other underground railways in connection therewith) will be allowed free use of the Company's Subway, which leads from the South Kensington Station direct into the grounds of the Museum.

Each member is entitled to a card for himself (which will not be transferable) and a card for a lady. These tickets have now been issued. Any member who has not received his tickets is requested to communicate with the Secretary. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by members, at the price of 5s. each, if purchased before the day of the Conversazione. On that date the price will be 7s. 6d.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary at the offices of the Society, John-street, Adelphi, W.C. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman, and must be signed by the member applying for it.

Tickets will only be supplied to non-members of the Society on presentation of a letter of introduction from a member.

It will greatly facilitate the arrangements if members requiring additional tickets will apply for them at as early a date as convenient.

The Council reserve the right of stopping the sale of tickets or of raising the price, if it is found necessary, in order to restrict the number of visitors within reasonable limits.

Further particulars as to the Musical and other arrangements will be given in the Programmes which will be distributed on the evening of the Conversazione.

LAC.*

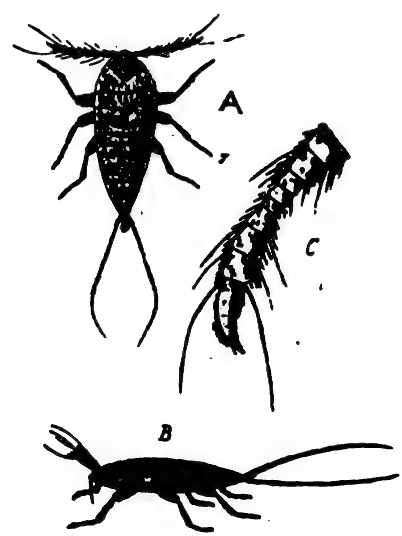
Origin of Lac.

Lac is a resinous excretion produced by a small insect. This insect, *Tachardia lacca*, belongs to the great order of insects known as the *Hemiptera*, or bugs, plant lice or scale insects. The most important characteristic of the members of this order is that they are furnished with powerful mouth parts, in the form of a piercing and sucking beak or proboscis. The family of the *Tachardia lacca* are the *Cocidea*. The majority of the members of this family are dangerous pests to crops and trees of many kinds, existing on the vegetable sap which they suck up through their probosces, which are inserted into the succulent tissues of the host. Coffee, tea, and other plantations alike suffer greatly at times from the ravages of these insects.

It is a curious fact that the lac insect should first be introduced to us as an enemy to cultivation, whereas, through the product of its depredations, it eventually obtains a high economic value. Nor does the lac stand alone as a useful member of the *Cocidea*, since another well-known scale insect, *Coccus cacti*, produces the red colouring matter known as cochineal; and *Ericerus pela*, a Chinese scale insect, secretes copiously a waxy matter that is used in the manufacture of candles in that country.

* * * * *

Fig. 1.



[illegible]

Let us suppose we have a tree infected with the lac insect somewhere in a grove by the side of an uninfected tree. About the first week in July the

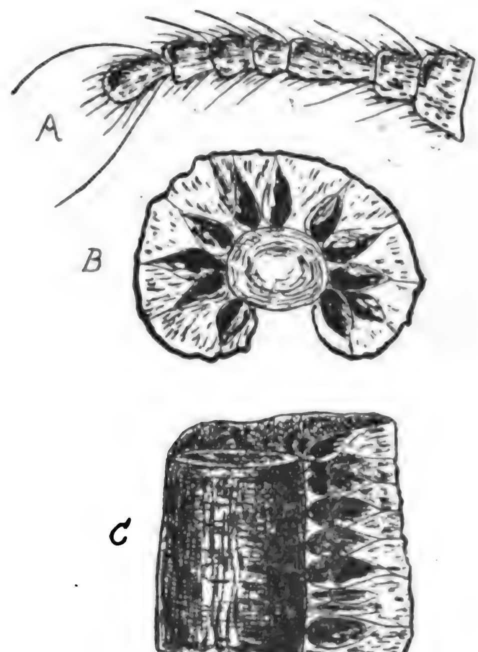
* Extracts from a paper read by Mr. A. F. Suter before the Paint and Varnish Society on March 11th, 1909.

larvæ begin to emerge from the incrustations on the twigs of the infected tree, and crawl away in quest of fresh feeding ground. They are then minute creatures of an orange red colour of elliptical shape, and measure about 1-40th of an inch. They resemble in appearance an ordinary bug, have no recognisable separation of body into head, thorax and abdomen, and are devoid of wings. They possess, however, six powerful legs, one pair of articulated antennæ, and a pair of small marginal eyes. Lastly, they have two very long white hairs that stand up at the anal extremity on the penultimate segment of the body. At this stage it is impossible to differentiate between the two sexes by the naked eye; in fact, the only distinction seems to be a difference in the articulation of the antennæ. For some 15 to 20 days the swarming continues, until the twigs assume quite a reddish colour and are literally alive with larvæ. The absence of wings prevents them from leaving the mother tree, so that the majority of them perish, being unable to proceed far enough by their own efforts to obtain new feeding ground, or else being incapable of piercing the bark of the twigs with the proboscis. The more fortunate ones are carried away to the other tree by the wind, birds, bees, and small animals such as squirrels and monkeys. Now the reason for the prolongation of the swarming period is apparent. Had it been completed in one day, climatic influences, such as heavy rain or total absence of wind, might have destroyed the whole brood.

As it is, let us assume that only a few larvæ have found their way to the neighbouring tree already mentioned, and there, on a soft sappy twig, fixed themselves on to the bark in a compact little colony. This little colony will now exclusively absorb our attention. The bark is punctured and the process of sap assimilation begins at once. In course of time we observe a light yellow, resinous incrustation forming round their bodies very gradually, which is due to the transformation of the plant sap—in the process of digestion—to a resinous excretion. While the insects are building their own prison, so to speak, they are undergoing structural changes all the while, the larvæ being gradually matured into the perfect male and female insects.

At a period of from 30 to 60 days after the swarming—that would be, say, from August 1st to September 1st — the incrustations are complete. The insects have totally disappeared from view, being now fully encased in the resin, and all that is apparent are innumerable tiny tufts of white hair or cotton filaments, covering the incrustations like a mould. What these filaments actually are we shall see later. If at this stage we break a portion of the incrusted mass open, we find it to be of a cellular structure, and that there are two kinds of cells, namely, a large circular cell, and, secondly, a smaller ovoid cell. The former are much more numerous than the latter, and contain the female insects. These cells are externally indicated by the white tufts above mentioned, while the smaller cells, containing the young males, are apparently without any opening. A closer inspection of these filaments, covered with white powder, will reveal that there are always three individual bunches close together, immediately above three tiny apertures in the incrustation. These three orifices are situated triangularly with respect to each other, two being closer to each other than the third, which is the largest and represents the anal aperture of the female insect, while the former two bunches of filaments are the attenuated extremities of the tracheæ (organs of respiration).

FIG. 2.



A Antenna of young female Larva
B·C Sections of a piece of Sticklack
showing rough arrangement of cells

Between the middle and the end of September the metamorphosis of the male insects is complete, and they begin to emerge from their cells. This they do by breaking the end of the cells open and crawling out backwards. They are then a little larger in size than the young larvæ at their exit from the parent insects, and are, by the naked eye, not easily distinguishable from them. Their structure, however, is different. They possess larger antennæ, which consist of nine or ten distinct articulations; four eyes, two lateral and two underneath the head; two long, hair-like appendages, covered with white powder, proceeding from the penultimate segment above, and a beaklike horny extension from the last segment, curved a little downwards and composed of two members, an upper and lower one, both grooved and

forming together a cylindrical channel, through which the semen is conveyed into the female.

The males, immediately after exit, exhibit an extraordinary energy and mobility, and can be seen busily engaged in crawling all over the incrustations, visiting the females. For some days the swarming of the males, as we may call it, continues. Each individual immediately proceeds to visit as many females as possible, after which function the male dies. Impregnation, therefore, seems to be the sole object of the fully developed male. The relative number of males to females has been calculated to be as low as 1 to 5,000, but, from the accounts of different observers, this proportion varies largely.

The encased female now undergoes a remarkable process of retrogression. The legs, antennæ, and the whole of the chitinous part of the body become almost indistinguishably incorporated with the surrounding resinous incrustation, so that on removal of the secretion, the insect appears again in almost a larval state. The abdomen of the female increases correspondingly, and becomes filled with an intensely red fluid, surrounding the ovary. This red fluid is the colouring matter, known as lac dye. The only other fully developed organ (besides the ovary) in the female body is the proboscis, which still goes on extracting the juice from the plant for the purpose of nourishment. I may state here that the exudation of the digested plant sap appears to be a viscid secretion from the anus of the insect. After impregnation the female insect goes on increasing for another three to three and a half months, when the new brood appears. The last month is evidently a period of rest, and during this time from all appearances, the insect lies dormant and abstains from food. The next stage, that is the issue of the new brood of larvæ during December, closes this interesting life cycle, which completes itself in a period of from four to six months. This explains the fact that certain parts of India, notably Mysore and Burma, yield not only two, but occasionally three crops per year, which is no doubt chiefly dependent upon the climatic and topographical conditions.

* * * * *

Manufacture and Commercial Aspects of Lac.

Cultivation.—As we have seen above, there are two yearly crops of lac in most parts of India, and, although the time of collection varies in the different provinces, the first crop generally falls between March and May, and the winter crop between October and February.

The lac is collected by natives exclusively, chiefly by forest villagers, who perform this operation in the most perfunctory way, taking little care for future crops, but often denuding the trees completely for the purpose of immediate gain. It is only in a few provinces where the collection of lac has attained considerable dimensions, that actual cultivation on scientific principles has been attempted, and as often or more by private enterprise than under the supervision of the Indian Forest Department. Here the trees are leased to the villagers, who engage themselves by contract not to remove more than 60 to 75 per cent. of each tree's crop, leaving the remainder for the purpose of seed; they are also bound to infect a certain number of fresh trees every year. This they do by lopping off, a few days before the swarming, some twigs covered with the healthiest incrustations, lightly wrapping them in a bundle of long grass, and tying them on to some sappy branches right up in the crown of some other tree. The grass is provided to assist the swarming larvæ to reach the new branches, and the seed twigs are placed so high that the insects which fall off on swarming may fasten themselves to the lower branches.

During the last twenty years many and extensive experiments have been made under the supervision of the Forest Department in various districts, but most of them have ended in utter failure. No doubt this is partly due to ignorance of the life cycle and other peculiarities of the insect on the part of the workers, but it must not be lost sight of that the insect itself has many more or less predacious enemies. Both birds and monkeys prey upon the insects, feeding either upon the new sweet lac or on the insect itself. Then there are ants of various species, swarming on the incrustations to lick up the sweet excrement exuded by the insects, which often destroy the whole brood affected. Furthermore, there are caterpillars belonging to the species of *Galleria* and *Emblemma*, which are known to hatch their larvæ in the new incrustations. Parasitic fungi may also grow on the lac, and by covering portions of the sticklac, kill off the animals situated underneath. Forest fires often destroy the crop of an entire district, and unseasonable heavy rain at the time of swarming of the young larvæ often does very great damage. Frost and hail are also extremely harmful.

As a general rule, the winter crop is almost always of more value to the grower, and it often happens that through adverse influences, as mentioned above, the summer crop produces no return whatever, but is barely sufficient for the propagation of the insect.

Collection and Manufacture.—The method of collecting the lac usually consists of breaking off the branches covered with incrustations, before the young larvæ have swarmed. This, of course, results in obtaining the lac cells, still containing the red colouring matter, which we know to be the lac dye, now no longer used. It has long been a moot point, whether this is the proper period of collection, since the lac dye has to be removed as thoroughly as possible before manufacture—in fact, to a certain extent, the value of the finished product is inversely proportional to the quantity of lac dye present; and it has naturally been suggested that the lac would probably be of superior quality if collected after the swarming of the new brood. Such a lac is actually in existence, known in India as "phunki" sticklac, but Dr.

Hooper, a Government official of Calcutta, has conclusively proved that this lac still contains a fair amount of this powerful colouring matter. In some localities, the incrustations are broken off from the twigs, which latter are left intact on the trees; or else the branches may be broken off, and then the resin detached by hammering with a wooden mallet before sale. In any case, the lac is then sold by the native collectors to the European or native middleman, who takes the article to the nearest factory.

Nearly the whole of the manufactured lacs of commerce may be said to be manufactured principally by hand in the neighbourhood of Mirzapore and Calcutta. In the factory, the lac-bearing twigs are broken into short lengths, technically called sticklac, either by hand or machinery. This sticklac is crushed by ordinary grain mills or by steam-driven roller mills. The resulting substance is then separated into three different masses, and graded as follows:—(1) Fragments of branches and twigs, used as fuel; (2) fine dust, consisting of minute fragments of lac and dirt, which is used for local consumption; and (3) granular lac, known in the trade as seedlac. This seedlac is then washed in tubs with a continuous supply of fresh water, at the same time being reduced to finer particles by treading or pounding. The wash-water becomes claret-coloured by the removal of the larger proportion of the lac dye, especially when the lac is being treated with a weak solution of sodium or potassium carbonate (in the form of crude plant-ashes). This washing extends over twenty-four hours. In the process of reducing the lac to a finer grain, a further quantity of a fine resinous powder is obtained, and this is also collected and sold for local consumption. After being washed, the seedlac is exposed on drying floors to the atmosphere and light, by which it is thoroughly dried. and, to some extent, bleached.

At this stage of the process the materials for adulteration are introduced, viz., yellow arsenic, commonly called orpiment, rosin, or both. The orpiment, which serves merely a mechanical purpose. makes the lac opaque, and imparts a rich, pale straw colour. It is introduced only into the manufacture of the finest grades of shellac. The admixture of rosin serves to lower the melting point of the seedlac. In order to obtain a satisfactory product, the lowering of the melting point is a desirable factor, and the use of a certain amount of rosin has, therefore, hitherto been deemed necessary by the manufacturers, 1 to 3 per cent. being the normal amount permissible.

The orpiment is ground to a fine yellow powder, then mixed with the seedlac, and the quantity of rosin and the whole mixture is then placed in very long, narrow cloth bags, 10 to 12 feet in length and 2 to 3 inches in diameter. These bags, when charged, are held by two persons above and between two rows of open coke or charcoal fires. The operators slowly twist the two ends in the opposite direction. The heat melts the lac, and the steady squeezing of the bag causes a continuous oozing from the portions exposed to the fires. In this manner the whole of the contents of the bag are eventually emptied, dripping from the bag on the floor between the fires, either into troughs containing warm water, or else on heated stone flags. Portions not equally or sufficiently melted are scraped up and returned into the next bag. The melted lac is taken up from the troughs or stones while still plastic by a third person and stretched into a thin sheet, from which all impurities, like fragments of wood or charcoal or ashes, are picked out. On cooling, this sheet is broken up, and constitutes the class of lac which we know as shellac. All dark-coloured and dirty portions are picked out, and the rest of the broken sheets graded according to purity and colour.

No portion of the lac is regarded as useless. The parings and fragments of every stage of the manufacture are thrown back for re-melting and made into fresh sheets. More highly coloured lacs are treated in the same manner, but pulled into thicker sheets, and then broken up. This is the garnet lac, while button lac, instead of being drawn into sheets, is allowed to drop from the bag on a smooth surface, where it cools and hardens in the shape of circular buttons, about ¼-inch thick, and of varying diameter. After the melting has been completed, the bags are boiled for the purposes of gaining the residuary matter, known in India as kiri-lac; from this two further inferior qualities of button or plate lac are made, chiefly for local consumption.

The above description applies to the hand-made native lacs. In modern factories, supervised by Europeans, where steam power is employed, the principles of manufacture remain substantially the same as those practiced by the natives, the difference being actually only an increase in rapidity and magnitude of production. Orpiment is not introduced into any machine-made shellacs.

The lac is now packed into wooden cases, which are covered with gunny, iron-hooped and marked. Cases of orange and garnet lac usually contain an average of two bazaar maunds (a bazaar maund equals 2 qrs. 26⅛ lbs.) net, while button lac is packed in cases of 3 maunds net. The manufacturer may be either under contract to supply the whole of the crop's output to one shipping agent in Calcutta, or else his stock may be bought up by several agents, who have the goods sent down by rail to the port for shipment.

Industrial use of Lac.—In India, lac enters largely into the agricultural, commercial, artistic, manufacturing and economic operations of the people. Large numbers of natives find employment in the work connected with the propagation, cultivation, collection and manufacture of the various grades of commerce. In the Indian villages it is used as a varnish or a colour medium by the wood-turner in the production of furniture, toys, boxes, platters, &c. The metal-worker employs coloured lacs for the ornamentation of metal work. The silver and gold-smiths use it to load hollow silver and gold wares, such as rings, dagger, and sword handles, &c., while more humble

personal ornaments, like bangles and anklets, are entirely made from it. Indeed, it is highly probable that one of the very earliest utilisations of lac was this very preparation of peasant jewellery. In the Punjab and other provinces, it is largely employed in the manufacture of painted pottery.

In Europe the industrial uses of this valuable product are not less varied, but, of course, these are well known, and I need hardly go further into the matter, beyond enumerating the different industries. Probably first and foremost in the consumption of the article stands the spirit varnish manufacturer; next comes the hat industry, where large quantities of lac are used for stiffening the felt, both in alcoholic and alkaline solutions. The maker of sealing-wax consumes a fair share of lac, while the article is also employed in the manufacture of insulating material for electrical appliances. The extensive application of lac in the comparatively young manufacture of gramophone records is said to be the reason of America's enormously increased consumption of late years, while in pyrotechnics lac is used in powder form, owing to the fine yellow flame it produces on ignition.

TURKISH LICORICE.

The licorice plant has been cultivated, according to precedence of date, in Spain, Italy, Greece, the Ottoman Empire, Russia, China, Turkestan and Persia. The yearly production of dry licorice is as follows:—Spain, 1,120 tons; Italy, 4,480; Greece, 2,240; Turkey, 33,600; Russia, 22,400; China about 600 tons; and Persia and Turkestan, 300 tons. In Asiatic Turkey, licorice root is found in sandy and damp places, more especially on lands near rivers. It is dug by peasants from depths of from 10 to 20 inches, and sold on the spot at prices varying between one farthing to a half-penny a pound. The licorice produced in the province of Aidin is said by the American Consul-General at Constantinople to be the best in the world. It was first discovered in 1848, by an Italian, who, in company with an Englishman, began the business of collecting and exporting it to the United States. There remains to-day only one of the factories for the making of licorice paste, that at Senke, which produces annually 4,500 cases of paste, each of 220 pounds. Within eleven years Smyrna, which is the seaport of the province of Aidin, has exported 288 million pounds of dried licorice and 18 million pounds of licorice paste. The product in the district of Aidin is increasing. During the three years, 1904, 1905, and 1906, the province produced an annual average of 25,395 tons of undried licorice root. Drying the root reduces its weight to 15,360 tons, of which 10,240 tons were exported to the United States, and 1,536 tons to France, Italy, &c., while the balance was transformed into paste in the country itself. The ground where the plant is grown is rented each year by the merchants who deal in this article. Upon payment of the rent, the tenants have the right to dig, and export the root during the interval between September and May. The digging and transport of the root is given by contract to the peasants, or the latter work by the day for the tenant. According to the temperature and the season, a labourer can dig from 80 to 150 pounds a day. The annual rent of the ground varies from one shilling and fivepence to three shillings and sixpence an acre. In the following provinces of Asiatic Turkey the plant is cultivated to a considerable extent. Aidin—in the valleys of the Meandere, and the Giediz, especially the cazas of Menimen, Magnesia, Akhissar, Kassaba, Salihlar, Alachehir, Senke, Aidin, Nazeli, Tchine, Karadja, Sou, Bosdoughan, Seraikieni, Denizli, Boldan, Bayindir, Tyre, Endemish, Milas, Makri; Syria and Aleppo—in the valleys of the Nehr Az, Aksu and the Euphrates; Beirut, Bagdad, Mamouret-ul Aziz (Harput), Bassorah and Jerusalem.

A NEW WAX PLANT.

It has been recently discovered that the candelilla plant contains wax of an excellent quality, and in sufficient amount to make it extremely valuable. The plant is found growing in the following States of Mexico: Tamaulipas, Coahuila, Nuevo Leon, Chihuahua, Durango, Zacatecas, Sonora, Sinaloa, Baja California, Jalisco, Puebla, and San Luis Potosi. The plant is described as growing to a height of from three to five feet, in the shape of stalks without leaves or thorns, as many as a hundred stalks springing from the same root. The stalks are about a quarter of an inch to half an inch in diameter. The American Consul at Tampico says that the plant also contains rubber, but not sufficient to make its extraction profitable. Of wax, however, it contains a high percentage, averaging from three and a-half to five per cent. The wax is of a light colour, very hard and has a high melting point, which places it in the front rank of all vegetable wax. Purified it will make, it is said, the best quality of candles, lasting, and giving a brilliant light. Dissolved in turpentine, it makes an excellent varnish, and it is also used for the manufacture of shoe polish. It it said to give more lustre than the high-priced Carnanba wax from Brazil, which is at present exclusively used for the latter purpose. Purified and moulded into phonograph records, the candelilla wax will register the sounds perfectly. Successful tests have also been made with reference to its adaptability for the insulation of electric wires. Another use for this wax would be its substitution for beeswax in pharmaceutical laboratories, where its hardness and higher melting quality in the manufacture of plasters and ointments, in which beeswax is now the principal ingredient, would, it is said, make it especially serviceable. This wax can be bleached perfectly white and burning it gives off an agreeable odour.

HOME INDUSTRIES.

The Cotton Outlook.—If the estimate of Messrs. Niell Brothers is near the mark, 13,000,000 bales of cotton represent the probable total of the season's takings by spinners, and 12,850,000 the actual consumption. Putting the crop at 13,550,000 bales, there will be a substantial addition to the world's stores. Discussing the prospects for next season, Mr. J. W. Soady thinks that, except in Texas, there will be some reduction of the acreage under cotton. In his opinion, the natural increase in the opening up of new land for cultivation year by year has been more than offset this year by the relatively large increase in food crops, and generally he believes that the South is being educated to the necessity of a diversification of crops. Meantime, the Master Spinners' Association have unanimously resolved to take a ballot of those spinning American cotton on the subject of short time. The proposal is to stop the mills each Saturday and Monday between July 10 and September 27. In this way it is hoped that flagging trade will receive some stimulus, it being admitted that the over-production of yarn is one cause of the unsatisfactory state of the market. It remains to be seen whether more than 20 per cent. of those with whom the decision rests are against the proposal, which cannot be carried unless 80 per cent. of the voting is in favour of it. Three months ago the trade was not willing to accept this measure of compulsory short time, but the continuance of unfavourable conditions may have changed opinion. If the spinners of American cotton determine on short time, it may be expected than an attempt will be made to get the spinners of Egyptian cotton into line, but at present they are divided as to lessening the output in a general movement. Manufacturers of piece goods are also not able to run short time as a body owing to want of organisation. There can be no question that the spinning trade is not paying at present, and extra stoppages at most of these mills, amounting to 186 hours during the next three months, is an obvious way of improving the margin. Assuming that these stoppages are brought about, as is most probable, there will still be a considerable minority outside the Federation working full time.

British Capital Abroad.—When recently the Prime Minister stated his belief that it was to the advantage of home industries that British capital should be invested in other lands sharp exception was taken to it, but in his paper read before the Royal Statistical Society, Mr. George Paish strongly supports the Premier's view. Mr. Paish says that the investment in the last sixty years of about £2,500,000,000 of British capital abroad has been one of the main causes of the vast growth of British trade and prosperity in the same period. By building railways for the world, and especially for the young countries, Great Britain has enabled the world to increase its production of wealth at a rate never previously witnessed, and to produce those things which this country is especially desirous of purchasing, namely, foodstuffs and raw materials. By assisting other countries to increase their output of the commodities they are specially fitted to produce, British industries have helped those countries to secure the means of purchasing the goods that Great Britain manufactures. Mr. Paish estimates that in the twelve months ended June, 1908, the new capital subscribed in this country for India, the Colonies, and foreign countries amounted to £110,000,000, and the amount for the year ended June, 1909, is estimated at £175,000,000, making a total of no less than £285,000,000 subscribed in the last two years.

Coal and Taxation.—Coal owners have much occasion for anxiety just now. The Coal Mining (Eight Hours) Act comes into force on July 1; as was shown in these Notes last week, it is already causing serious friction between masters and men, and it has yet to be shown that it will not add appreciably to working expenses, and so assist foreign competition, already very formidable. And now there is the Chancellor of the Exchequer's proposal to tax ungotten minerals. During the recent debates upon the Budget in the House of Commons the Chancellor observed that "there is no uncertainty at all as to what is meant by minerals." Few lawyers would assent to that proposition, but there can be no doubt whatever that ungotten minerals include the unworked coal deposits of the country. The Budget proposal is to impose a duty on the capital value of all undeveloped minerals at the rate of a halfpenny for every 20s. of capital value. Should the proposal become law every person who owns land under which minerals exist will be required to pay upon the assessed value of such minerals although he derives no income or return from them whatever. In the case of coal the question arises as to what depth it is really economical to work coal measures, and, therefore, to what depth beneath the surface should the claim for taxes extend. It is doubtful whether coal can be profitably worked much below 4,000 feet, but however that may be, the acceptance by Parliament of the Chancellor's proposal to tax ungotten minerals could hardly fail to react seriously upon the present cost of output. It is estimated the halfpenny tax would amount to over £5,000,000 per annum, and this would in fact be a duty on the coal which is actually worked.

Coal Exports.—It is a remarkable fact that notwithstanding the large quantity of shipping unemployed, and the shrinkage in consumption for industrial purposes abroad, the exports of coal from the United Kingdom for the five months ended May last exceeded by some 4,000 tons the exports for the corresponding period of 1908. In steam coals there was an increase of 190,000 tons on 17,900,000 tons. Yet most countries show decreased imports. The principal increases were to Italy from 3,455,000 tons to 3,820,000 tons; to the Straits Settlements from 98,532 to 200,295 tons, and to Chili from 236,000

to 331,852 tons. Probably the explanation is to be found in the uneasiness of consumers as to the course of events in Wales and Scotland which has led them to assure themselves of as much of the coal due to them under contract as they were able to store, and in the fact that this has been going on for some time, culminating in the present glut of tonnage in the Welsh ports, and the large exports from Scotland. Stocks are so large that if a strike should take place it would be a considerable time before much pressure for coal would be felt.

Miners and the Double Shift — At their meeting on Friday last the Miners' Federation passed a resolution against any reduction of wages in consequence of the Eight Hours' Act. A national conference is to be summoned in order to arrange common defensive action. It is not the men on piece rates who object to the Act. The hewers, who are paid by their output, expect to recoup themselves by increased activity during the shorter working day. The difficulty is with the men on day wages. It is believed that so far as South Wales is concerned the difficulty might be got over if they would consent to the double shift, but for reasons that are not very convincing they have hitherto refused to agree to it, though in many other districts it is already in operation. It will be impossible for South Wales to compete on equal terms with other districts where the expenses of working are lower unless the double shift is conceded. In many of the Welsh mines the men have so far to travel underground before they reach the face that not more than six hours per day of effective industry can be counted on. It is difficult to believe that the Welsh miners will persist in their opposition to the double shift if the masters are ready to meet them half way, as they are said to be, in regard to other matters in dispute.

Trackless Trolley Cars.—The Sub-Committee of the Leeds Corporation which recently visited the Continent to study the question of railless electric trolley cars has issued its Report, which speaks favourably of the system, and recommends its installation between Leeds and Farnley. The Report gives particulars of the working expenses of some of the Continental installations. With the Mercedes-Stoll system the overhead construction cost £1,690 per mile, the chassis (without bodies) for the cars £550 each, and the working expenses, including such items as taxes and repairs, amounted to only 4·52 pence per mile. At Milan, on the Filovia system, the cost of operation was 5·65 pence per mile. It may be gathered that the Continental services are somewhat below the standard expected in the neighbourhood of large English towns, where these costs would most likely be exceeded. The omnibuses employed on the Continent are mostly single deckers, with comparatively small seating capacity.

Australian Combed Wool. — Australia annually produces wool to the value of about £24,000,000, the bulk of which finds its way to the United Kingdom and the Continent. Most of it is in the greasy condition in which it left the sheep's back, the work of scouring and combing being performed in the countries to which it is sent. These two processes reduce the weight and bulk of the wool about two-thirds, but increase its value by at least 25 per cent., say £6,000,000, making the total value of the wool, if thus treated, about £30,000,000. Last month the first shipment of Australian combed wool ever exported left Sydney for Japan. Local manufacturers have for years made their own tops, but the possibility of an export trade was never considered. The shipment referred to above consisted of 200 bales, and a similar quantity will be despatched by every Japanese steamer leaving Sydney during the next few months. The Japanese purchasers of Australian wool have, hitherto, done their own scouring and combing, but they anticipate that the Australian export of tops to Japan will enable them to extend their markets in the East.

Fire Insurance with Profits.—Attention has recently been given in these Notes to insurance developments of one kind and another, and a correspondent now directs notice to what seems to him to be the anomaly that whilst the with-profit policy has been forced more and more upon life insurance companies by the demands of public opinion, fire insurance offices as a body have steadily withdrawn from this kind of business. At one time there were several companies in London which gave to their policy-holders some return on their policies should they make no claim against the company, but within the last few years these have been absorbed by other institutions, and taking fire insurance business as a whole the public have come to consider that after having paid the rates securing them against loss from fire they have obtained all the benefits from the operation that can be expected. There is now only one old insurance company doing a general fire insurance business on profit-sharing principles. This company—the Essex and Suffolk Equitable Insurance Society—has a record which may be called unique. Established as far back as 1802, it was formed on the mutual principle, but was not allowed to conduct business in the London area, or in Scotland and Ireland. It was a company with the county of Essex foremost in its title, yet owing to its constitution four-fifths of the inhabitants in that county were unable to insure with it! It was not until 1906 that an Act was passed through Parliament revising the constitution of the society, enlarging its capital, and removing all restrictions as to the area in which its business may be conducted. The principle on which the company has worked is to charge ordinary rates in most cases, and to repay to the policy-holders, in cash, at the end of every five years (subject to certain conditions as

claims for compensation) as large a proportion as can be afforded of the premiums paid. This bonus, for over 100 years, has ranged from 25 per cent. to 50 per cent., and for the past twenty-seven years the latter figures have been paid without a break. The result is, that every five years an assurant who has to pay £10 per annum to the society, has received in actual cash £25 as bonus. One cannot quite see why other fire insurance companies do not do something of the kind, even though in lesser degree.

CORRESPONDENCE.

PROPOSED CONFERENCE ON INDIAN ART.

Mr. Cecil Burns's paper on "The Functions of the Schools of Art in India" read before the Royal Society of Arts, Indian Section, on the 27th of last month, under the chairmanship of Sir Hubert Von Herkomer, discussed some important problems connected with the subject of Indian art—a subject which I venture to think has perhaps been too little attended to by our Society.

The reason of the scant attention which it has received is, no doubt, mainly this—that Indian art is a subject which can only be rightly dealt with by experts, who are few in number. The interest in Indian art manufactures and Indian industries is already great and growing; Indian art, pure and simple, which should be the basis of all, is studied and cultivated by a very few. It is well that the Government has recognised the importance of the matter by founding art schools in some of the important centres of the Indian continent, by attending to archæological remains, and, to a certain extent, to other artistic relics of the past; but the field is vast.

Among the cultured Europeans in India, while many have inclination, few have time to devote to the real study of this subject. In London, perhaps, where retired Anglo-Indians of leisure are to be found, where such societies as ours exist, and where presentments of Indian art (as well as that of other countries) are exhibited in these great national institutions—the British Museum, the South Kensington Museum, the Victoria and Albert Museum, the Imperial Institute, and the Indian Institute at Oxford—there are fields of study and opportunities for it, as good as are to be found in any centre in India.

Mr. Cecil Burns's paper was full and interesting on its particular branch of the subject, but those interested must have felt how wide the field was, and how much thought and fruitful discussion might most naturally grow out of topics touched on by the lecturer, and the suggestions made. While speakers who joined in the discussion afterwards were worthily selected to lead it, there were many present who could have made valuable contributions to it and whose experience eminently fitted them to inform and suggest.

I was led before leaving the hall to make a proposal which I am not without hope may bear fruit; and perhaps you will allow the preliminaries to be discussed in your columns. It is that there should be assembled in London a conference of Indian art. There is so much of interest, so many fields of inquiry, so much room for suggestions, that a short meeting would be of little use; two days, or perhaps three, each day with a session of 2½ or 3 hours, would be necessary to make a conference really useful. As above said, there are many in London interested in the subject, and some experts. A committee might be formed to select the readers of papers and leaders of the discussions, and also to prepare a small and very carefully selected collection of exhibits to illustrate papers and stimulate inquiries.

The philosophy of Indian art and its religious basis has recently found a most eloquent and enthusiastic exponent in Mr. E. B. Havell, formerly Principal of the School of Arts, Calcutta. Mr. Havell's theories and conclusions, based upon much research and set forth with dignity and grace of diction corresponding to his belief in his cause, form an important contribution to the study of Indian art, if only because he speaks from intimate knowledge, considerable research, and strong conviction of the soundness of the views which he sets forth. There are many, perhaps, to whom these views will not commend themselves, but all lovers of the subject must be well pleased that there has arisen one who can plead eloquently, and set forth in due array, as it were, in the court of artistic opinion, views which, perhaps, few expected to hear propounded in the defence of what is very generally regarded as grotesque and extravagant.

Besides Mr. Havell's sumptuous volume, which is eminently fitted to stimulate thought on the abstruser aspect of Indian art, public attention has been strongly drawn to the subject by the recent correspondence in *The Times*, and the deputation to Mr. Runciman, President of the Board of Education, about the Indian Collection at South Kensington.

There may, therefore, be said to have arisen at the present time a special interest in the subject which should make the occasion favourable for a conference on Indian art, which I venture to advocate.

W. COLDSTREAM.

69, West Cromwell Road, S.W.

OBITUARY.

GEORGE FREDERICK DEACON, LL.D., M.Inst. C.E.—Mr. George Frederick Deacon, of Coombe Wood, Addington, died suddenly at his office in Great George-street, Westminster, on the 17th inst. Born at Bridgwater in 1843, Mr. Deacon was educated at Heversham and Glasgow University. In

1865 he accompanied the Atlantic Telegraph Expedition on board the *Great Eastern* as assistant to Lord Kelvin, who was then acting as scientific adviser. At this time he had started practice as an engineer in Liverpool, and six years later he was elected borough and water engineer of that city. While holding this position he invented the differentiating waste-water meter. He resigned the position of borough engineer in 1879, and, devoting his attention to the water supply of Liverpool, in conjunction with the late Mr. Thomas Hawkesley, he completed, as engineer-in-chief, the first instalment of the scheme, which cost £2,500,000, in 1892. He started practice in Westminster in 1890, and became president of the engineering section of the Sanitary Institute in 1894. Three years afterwards he was chosen president of the mechanical science section of the British Association, which was then meeting at Toronto. He received the Telford, the Watt, and the George Stephenson medals of the Institution of Civil Engineers, and was the author of many addresses and writings on scientific subjects. The honorary degree of LL.D. was conferred upon him by his *Alma Mater*, and he served on the Council of the Institution of Civil Engineers. He joined the Society of Arts in 1874; he read a paper on "Constant Supply and Waste of Water," in 1882, and he took part in discussions on several occasions.

QUESTIONS AND ANSWERS.

Readers in search of information which cannot be obtained from the usual sources are invited to make their wants known in the *Journal*, in the hope that they may be assisted in their difficulties by their fellow members.

On all communications must be written the name and address of the sender, not necessarily for publication, but as a guarantee of good faith.

Each question or reply should be written on a separate sheet of paper, and should bear such signature of the writer, and such address as he wishes to appear.

Questions which can be answered from the usual books of reference, will not be printed.

QUESTION.

MATERIAL FOR DIE-SINKING.—I have been informed that there is a substance, derived from the metal, tantalum, which is exceedingly hard and tough, and would therefore prove very valuable for die-sinking and engraving, and I should be glad to know more about it, and to hear whether it is possible to obtain it. The metal itself, as far as I understand, is exceedingly soft and ductile, so the derivative must be some compound. Practical gem engravers are very much in need of a material with the hardness of a diamond, but without its serious defect of brittleness.—DIE-SINKER.

ANSWERS.

EMBANKMENTS OF THE RIVER THAMES (see pp. 343 and 655).—Referring to the communication of Mr. H. B. Wheatley on the above matter in the *Journal* of the 18th inst., it may perhaps interest "Londiniensis" to know that Captain Perry published, in 1721, "An Account of the Stopping of Daggenham Breach, with the Accidents that have Attended the same from the First Undertaking." This is a most quaint and original book, and is descriptive of the various difficulties he had to encounter with the river authorities of the day, which were almost as trying as the physical difficulties of stopping the breach. In the absence of definite records it is impossible to determine by whom the original embanking of the River Thames was carried out. It must not be forgotten that, by reason of the deepening and canalisation of the river, which has been going on for centuries, its character has doubtless completely changed since Roman times, when it was probably a sluggish stream meandering through a chain of swampy lagoons, and reclamation was consequently a less formidable undertaking. I have charge of about 15 miles of the Essex sea walls in the estuary of the Thames, and the material of which these walls is composed, and the method of their construction, indicate that the original embankers of the River Thames were thoroughly skilled in this difficult work. The character of other walls under my charge on the Essex coast reveals the same condition of things. It is difficult to find on the marshes now, clay of the character used in their construction, and the "wallers" have curious theories to account for this state of affairs. Stuart Moore's "History of the Foreshore and Law Relating thereto," and Hall's "Essay on the Rights of the Crown in the Sea Shore," contain much matter of historical and antiquarian interest as to the embanking of the River Thames.—A. E. CAREY, M.Inst.C.E.

WHITE LEAD AND WHITE LEAD PAINT (see p. 624).—The merits and demerits of white lead have been, at all times, a fruitful source of controversy. Whilst hundreds of processes for improving it have been devised in recent years, they have, for the most part, failed to justify their introduction commercially, and have only proved of service in providing padding for books, and for increasing the revenues of the Patent-office, and what is known as the "old Dutch process," which has come down to us, with but slight modifications, from the time of the Romans, still holds its own in a large measure. The opacity of white lead is one of its most important properties, and it is here that the old process excels, and most modern inventions fail. The objections to the old process, on the other hand, are the difficulty of control, the length of time required, and the great risk of lead poisoning to those engaged in its operation; it is the latter disadvantage which, under the stringent regulations of modern days, has stimulated efforts to devise an alternative

method. Although, as already mentioned, the majority of such methods have had but a short career, there are now in this country at least two which seem to be making headway against the dead-wall of prejudice in favour of the old method, which is characteristic of the users of this material, and which has certainly been justified by past history. The process devised by the late Professor Bischof, some twelve years ago, and now in operation on a large scale at Brimsdown, is exceedingly ingenious. In this process, the lead is oxidised to litharge, which is then reduced to sub-oxide, and converted into hydrate, from which the white lead is produced by partial conversion into carbonate by exposure to carbon dioxide. The advantages offered by this process may be summarised thus:—(1) The proportion between the hydrate and carbonate—on which the opacity of the pigment to a large extent depends—is subject to accurate control. (2) No free lead can be present in the product, or objectionable compounds such as basic acetate, and it is of uniform fineness and free from grit. (3) The operation being entirely automatic, and after the formation of the litharge carried on entirely in the wet state, it is very advantageous from the hygienic point of view. Unfortunately white lead made by this process, whilst excellent as a pigment, suffered from some defects as regards qualities which did not commend it to the practical painter. It is only fair to say, however, that patient research has to a large extent overcome these difficulties, and that the process seems to be becoming firmly established.

There is another process which is of more recent origin, and, in fact, is still to a large extent in what may be called the "industrial experiment" stage, from which, however, it is rapidly emerging. Apart from the difficulties attendant upon specific processes of preparing the particular compound known as white lead, it has inherent defects which no process can obviate, such as its highly poisonous nature, and its liability to be blackened by sulphur. Many attempts have therefore been made to replace it by another compound altogether, and Hannay's process is of this order. The principle of this process is the production of lead sulphate direct from the lead ore (Galena), the galena being sublimed in a furnace and oxidised whilst in the gaseous state, with the resultant formation of basic sulphate of lead in an extremely fine state of division, which has an opacity, the absence of which in earlier methods proved a fatal stumbling block to the substitution of this compound. My only objection to this process is that the product should be called white lead, seeing that it is an essentially different material from that connected by the use of centuries with this name. That, however, "is another story."

As regards books, despite the importance of this substance, there is no standard work entirely devoted to it. Most of the text-books on pigments, however, devote a considerable space to the discussion of white lead: Zerr and Rubencamp, for instance, in their "Handbuch der Farben Fabrication" (of which an English translation by Mayer has been recently published) give a very comprehensive account, although recent English and American processes are barely referred to. Petit ["Manufacture and Comparative Merits of White Lead and Zinc White Paints." English edition published by Scott, Greenwood and Son] enters fully into the question of white lead paint, although mostly from the controversial standpoint, and Maximilian Toch ["Chemistry and Technology of Mixed Paints"] discusses the technology of white lead in an able and up-to-date manner. The following may be interesting from an historical point of view:—Pulsifer, "Notes for a History of White Lead and Lead Oxides" [1888]; Faure, "Histoire de la Céruse" [1899].—N. H.

STAINED GLASS WINDOWS (see pp. 597, 625, and 655).—Referring to the further query on this subject by "L. F. D.," I certainly think it is far more likely that the introduction of the tint referred to was due to the use of cobalt than to a change in the fundamental composition in the glass. I scarcely think that this latter would account for such a striking difference, although the composition of the early mediæval glass was of such an exceptional composition that one hesitates to say exactly what may have been possible in the way of colouring it. Of course, if one postulates that the change *was* due to the introduction of cobalt, one is faced with the pertinent query made by "L. F. D." as to how the sapphire blue of the early glass was produced, and everyone takes it for granted, as "L. F. D" says, that this glass was covered by cobalt, but what I want to know is, on what is this assumption based? Appert ("Notes sur les Verres des Vitraux Anciens"*) speaks of this sapphire, as though he was quite sure it was coloured by cobalt, but unfortunately gives no indication as to how he arrives at this conclusion. I consider that it is quite conceivable that copper may have been the chromogen in this case, for the following reasons:—

(1) Compared with a normal cobalt blue, this blue is much further towards the red end of the spectrum; moreover, it is very much less intense—this can be very well seen in one of the medallions from St. Chapelle, in the Victoria and Albert Museum, where a piece of cobalt blue has been inserted in the seventeenth century. If, further, one considers that the early glass was something over twice as thick as the later, and was coloured throughout its thickness, it is evident that its colour was really very feeble.

(2) One can produce a pale blue of this type from copper in modern potash glasses.

(3) There was a fine blue pigment used in ancient times, and extensively in fresco painting. Davy, early in the last century, proved this to be a highly annealing glass like smalt, only coloured by copper

* The only book I know of which enters into the technology of mediæval glass.

instead of cobalt. It is evident, therefore, that under favourable conditions, we can produce strong blues with copper.

(4) The composition of early glass is, as I have said, exceptional: it differs from later glasses, not only in containing a very large proportion of potash, but also in having an extraordinarily high content of lime and alumina, the latter, according to Albert, reaching 8 per cent. (I am bound to confess, however, that I am somewhat sceptical as to his results). Now the colouration of alumina is a different matter from that of silicates. The colour of the ruby, for instance, is due to chromium, not copper or gold as one would expect from analogy with glass; and Verneuil, who has successfully reproduced rubies, has signally failed in his attempts to produce artificial sapphires by means of cobalt. It is possible, therefore, that this peculiar composition may have resulted in the production of colours in ancient glass which have no parallel in modern glasses. As I think one cannot be too careful in distinguishing between results based on theory and those derived from practical experiment, I conclude by once more emphasising the fact that all this is merely conjecture, and that nothing short of actual analysis would justify one in giving a definite answer to this interesting query.—N. H.

NOTES ON BOOKS.

The Arts Connected with Building. Edited by T. Raffles Davison. London: B. T. Batsford. 5s. net.

This volume consists of the lectures on craftsmanship and design which were recently delivered, under the auspices of the Worshipful Company of Carpenters, by Messrs. K. W. Schultz, C. F. A. Voysey, E. Guy Dawber, F. W. Troup, A. Romney Green, M. H. Baillie Scott, C. Spooner, Laurence A. Turner, and J. Starkie Gardner. The aim of the Carpenters' Company in instituting and publishing these lectures was neither antiquarian nor academic, but, in the words of the editor, "to stimulate the ambition of craftsmen towards a high ideal of attainment." The lecturers are all persons well-known for their study of practical craftsmanship, they are all eager to see a revival of the best traditions of the past, and they are all one in their desire that each craft—brick-work, plaster-work, wood-work, metal-work—should be raised to its highest level and co-operate harmoniously with its sister crafts for the attainment of that most desirable end, the house beautiful. The book is enriched with 98 illustrations—admirably reproduced—of old and modern work, and it is comforting to note that, although we cannot now-a-days rival the wonderful wood panelling of Magdalen College, Oxford (which forms the frontispiece), the wooden roof of Westminster Hall, or of the Great Hall, Hampton-court, there are signs that the arts and crafts movement has done "something definite to stir in people a belief in the value of beautiful craftsmanship." It is of vital importance that such a belief should be fostered, especially among the craftsmen themselves, and nothing could be better calculated to this end than the careful study of this volume.

Proceedings of the First International Refrigerating Congress. Paris: Secrétariat Général de l'Association Internationale du Froid. 3 vols. 25s. net.

The first International Refrigerating Congress was held at Paris from October 5th-12th, 1908, and the full report of the proceedings, which has just been issued, fills three thick volumes. The congress was divided into six sections, and the numerous papers and discussions now printed in English, French, German, and Italian, deal with refrigeration in all its aspects. The rapidity with which the trade in frozen food has grown is amazing. Whereas in 1880 the number of carcases imported was only 400, in 1902 the total from Australasia and the River Plate had risen to seven and a-quarter millions. Development on a corresponding scale has taken place in connection with the butter, cheese and egg trades, and much attention is now being directed to the problem of the cold storage of fruit. Possibly one of the most interesting of the papers is that by Mr. F. W. J. Moore, of Tasmania, upon this question. Tasmania, the Garden State of Australia, is a paradise of fruit, but the voyage is so long and the changes of temperature so great that the difficulties of landing such perishable cargo in this country in sound condition are enormous. In the case of apples, however—in spite of many failures at first—success has now been achieved, and Mr. Moore is not without hope that it will soon be possible to bring to our tables such delicate fruits as grapes, peaches and pineapples, "with all their pristine bloom and flavour."

MEETINGS FOR THE ENSUING WEEK

Tuesday, June 29...Faraday Society, Institution of Electrical Engineers, 92, Victoria-street, S.W. Annual General Meeting, 7½ p.m. Ordinary Meeting, 8½ p.m. 1. Dr. R. Beckett Denison, "Researches on the Relative Rates of Migration of Ions in Aqueous Solution." 2. Dr. Henry J. S. Sand, "Apparatus for the Rapid Electroanalytical Separation of Metals." 3. Mr. Samuel F[illegible], "The Conditions which Determine the Composition of Electro-deposited Alloys."

Wednesday, June 30...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4 p.m. Annual General Meeting.

Junior Institution of Engineers (at Fishmongers' hall, near London-bridge), 8 p.m. Lieut. A. Trevor Dawson, R.N., "The Engineering of Ordnance." (Gustave Canet lecture.)

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FRIDAY, JULY 2, 1909.

All communications for the Society should be addressed to the Secretary, John street, Adelphi, W.C.

NOTICES.

CONVERSAZIONE.

The Society's annual conversazione took place at the Natural History Museum, Cromwell-road, S.W. (by permission of the Trustees of the British Museum), on Tuesday evening, June 29th. The reception was held in the Central Hall of the Museum by Sir William H. White, K.C.B., F.R.S., Chairman, and the following members of the late and present Councils:—Sir William Abney, K.C.B., D.C.L., D.Sc., F.R.S., The Lord Chief Justice, G.C.M.G., Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., Sir William Bousfield, M.A., LL.D., Mr. Robert Kaye Gray, Col. Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., The Hon. R. C. Parsons, M.A., Sir Boverton Redwood, D.Sc., F.R.S.E., and Mr. Carmichael Thomas.

The following portions of the Museum were open:—The Central Hall, containing cases of specimens illustrating Mimicry; adaptation of colour to surrounding conditions; protective resemblance, &c.; the North Hall, containing the collection of Domesticated Animals; the Bird Gallery, containing groups of British birds and nests, &c.; the Fish Gallery, the Shell Gallery, and the East and West Corridors on the first floor.

Concerts were given by the String Band of H.M. Royal Engineers (conductor, Mr. Neville Flux, A.R.A.M.) in the Central Hall, and the Red Band, under the direction of Mr. Thomas Batty, in the Fish Gallery. A selection of songs, instrumental music, &c., was performed on the Auxeto-Gramophone under the direction of the Gramophone Company, in the Shell Gallery.

The number of visitors attending the Conversazione was 1,458.

PROCEEDINGS OF THE SOCIETY.

ANNUAL GENERAL MEETING.

The Annual General Meeting for receiving the Report of the Council, and the Treasurers' Statement of Receipts, and Payments, during the past year, and also for the Election of Officers and New Members, was held in accordance with the By-laws on Wednesday last, 30th June, at 4 p.m., SIR WILLIAM H. WHITE, K.C.B., F.R.S., Chairman of the Council, in the chair.

The SECRETARY read the notice convening the meeting, and the minutes of the last annual meeting.

The following candidates were proposed, balloted for, and duly elected members of the Society:—

Adams, Arthur, 17, Blenheim-road, Bedford-park, W.
Ashcroft, Edgar Arthur, Assoc.M.Inst.C.E., Sande Gaard, Balestrand Sogn, Norway.
Bader, Frederick Robert, Assoc.M.Inst.C.E., 57, Chancery-lane, W.C.
Ballantine, W. J. H., Deputy-Magistrate, District Dinajpur, Eastern Bengal and Assam, India.
Black, David, 128, Upton-lane, Forest-gate, E.
Blundell, Thomas George, 30, Ferncroft-avenue, Heath Drive, Hampstead, N.W.
Cheney, Miss Elizabeth, The Needles, Peterborough, New Hampshire, U.S.A.
Clogstoun, Cuthbert George Wilder, Deputy-Inspector-General of Criminal Investigation and Railway Police, Madras, India.
Dickson, Archibald Allan Clifford, A.I.M.M., F.G.S., M.A.I.M.E., Rejoulie P.O., *via* Nawadah, E.I.Rly., Gaya District, India.
Dunscomb, Samuel Whitney, Junr., A.M., Ph.D., LL.B., 34, Pine-street, New York City, U.S.A.
Gourlay, William Robert, I.C.S., 8, Elysium-row, Calcutta, India.
Guggenheim, William, 500 Fifth Avenue, York City, U.S.A.

Hay, Alexander Mackenzie, "The Statist," 51, Cannon-street, E.C., and "Marston," Warlingham, Surrey.

Hoe, Robert, Junr., 113 East 55th-street, New York City, U.S.A.

Holmwood, Hon. Mr. Justice Herbert, Queen Anne's-mansions, S.W., and the High Court of Judicature, Calcutta, India.

Hulett, Hon. Sir J. Liege, M.L.A., J.P., Prince of Wales Hotel, De Vere-gardens, Kensington, W., and Pietermaritzburg, Natal, South Africa.

Huntington, Archer Milton, Audubon-park, West 156th-street, New York City, U.S.A.

Jeme Tien Yow, Taotai, Ph.B. (Yale, U.S.A.), Assoc.M.Inst.C.E., Imperial Peking-Kalgan Railway, Peking, China.

Law, Maharaj-Kumar Reshee Case, 8, New China Bazar-street, Calcutta, India.

Mitchell, Francis Henry O'Connor, B.A., Government School of Engineering, Insein, near Rangoon, Burma.

Nevill, James Forder, Bulmer, Burnt Ash Hill, Lee, Kent.

Nevin, Miss Blanche, Churchtown, Lancaster County, Pennsylvania, U.S.A.

Pike, Warburton, Union Club, Victoria, British Columbia, Canada.

Pollard, Herbert Edward, Public Works Department, Shanghai Municipal Council, Kiangse-road, Shanghai, China.

Preston, Arthur, 103, Clive-street, Calcutta, India.

Roberts, Charles T., M.I.Mech.E., Champion Reef, State of Mysore, India.

Ruthven, Dr. Jane Buchanan Henderson, M.D. (Brux), L.R.C.P. and S. (Edin.), Eagle's Nest, Johannesburg, Transvaal, South Africa.

Smith, Richard B., 407 West 57th-street, New York City, U.S.A.

Stuart-William, Albert L., Resident Engineer-in-Charge, D. H. Railway, Didwana, Jodhpore State, India.

Syfret, Stephen, M.D., Mowbray, near Cape Town, Cape Colony, South Africa.

van Deventer, Dr. C. Th., 20, Suriname-straat, The Hague, Holland.

Win, Maung San, Peterhouse, Cambridge.

Young, Colonel Sir John Smith, C.V.O., 13, Gloucester-street, S.W.

The CHAIRMAN nominated Mr. Noel Heaton, B.Sc., F.C.S., and Lieut.-Col. G. W. Macauley scrutineers, and declared the ballot open.

The SECRETARY then read the following

REPORT OF COUNCIL.

I.—ORDINARY MEETINGS.

The Session opened as usual with an Address from the Chairman of the Council. Sir William White commenced by referring to the assistance which was given by the Society to other kindred Associations, and especially to the Institution of Naval Architects, which for fifty years had held its annual meetings in the Society's hall, and in connection with which institution Sir William had first known the Society of Arts. From this indirect connection of the Society with the professional education of naval architects, the Chairman passed to a general consideration of the steps which had been taken in this country for the promotion of the technical training of those connected with naval matters, as shipbuilders, engineers, and naval officers. The record which he gave will serve as a valuable summarised history of the subject for future reference.

At the second meeting of the Session Sir Martin Conway gave an extremely interesting description of a part of South America which is perhaps less familiarly known to English people than almost any other district of that Continent—Bolivia and the part of Peru lying to the East of the Cordilleras, and the gold-fields of that country. In 1900 Sir Martin Conway read before the Society a paper on Bolivia, and on the present occasion he brought the information on the subject down to date, and showed how far the country, perhaps as rich as any part of the world in mineral wealth has been developed.

The next meeting was devoted to a paper by Mr. Eric Stuart Bruce, who was for some years secretary of the Aeronautical Society and who has given constant attention to the subject for a long time, on "Mechanical Flight." The paper dealt with the history of the subject, the early suggestions in 18[illegible] of Mr. Wenham, the experiments of Lilienthal (interrupted in 1896 by his death), and Sir Hiram Maxim's paper in 1894, down to the recent marvellous developments of the aeroplane by the Brothers Wright.

Next came a paper by Mr. G. Albert Smith on "Kinematography in Natural Colours." Since the cinematograph was first brought to perfection, it has been the aim of all those who were interested in it to apply to moving pictures some one or other of the various methods by which colour has been more or less satisfactorily added to photograph

pictures. When the three-colour principle was perfected and successfully employed, many inventors endeavoured to apply it to the cinematograph. In theory the task was not very difficult; but in practice it has always been found quite impracticable to give a sufficiently accurate register to three cinematograph pictures projected simultaneously upon a screen. Mr. Smith succeeded in solving the problem by using a single film on which alternate exposures were made through two filters, one of which allowed the orange and red rays to pass, and the other, the rays from green to violet, while both transmitted the yellow, and a certain proportion of white light. In practice, this system proved to be workable, and the result was shown in a number of cinematographic pictures, reproducing quite satisfactorily, and with very fair accuracy, the colours of nature. Since the reading of the paper, similar pictures have been exhibited in public, and there is no doubt that a very valuable addition has been made to the powers of the cinematograph.

The last paper, before the Christmas recess, was by Mr. Primrose McConnell, on Milk Supply. Mr. McConnell was able to speak with authority on the subject of pure milk supply, and he took up the cudgels on behalf of the purveyors of milk against some of the recent conclusions of the Royal Commission on Tuberculosis. It is probable that a good many medical authorities will not agree in theory with his views. On the other hand, there is not much doubt that the practical suggestions he made are well worthy of consideration, and it is to be hoped that they will be considered when the Bill on Milk Supply lately introduced into Parliament comes to be discussed.

The first paper after Christmas dealt with an artistic subject, "Gothic Art in Spain," and was read by Mr. Henry Brewer. Mr. Brewer gave an extremely interesting description of many of the principal Spanish cathedrals, and traced the development of Christian architecture in Spain as it grew out of the art established in that country by its Moorish conquerors.

In his paper on "The Part played by Vermin in the Spread of Disease," Dr. James Cantlie discussed the subject from the theoretical point of view, and showed how large a proportion of human disease is due to parasites, who pass a portion of their life history in the bodies of creatures other than man, some of them in insects and some in mammals. From this was drawn the obvious conclusion that human safety required the destruction of the original hosts of these disease-generating organisms.

The paper on "The Problem of Unemployment" by Mr. Bolton Smart, gave some account of the work which has been carried on at the Hollesley Bay Labour Colony under the Central (Unemployed) Body for London. Mr. Smart has been superintendent of the colony since its foundation, and he was consequently able to give a very full and accurate account of the results which had been attained, though his view was naturally biassed in favour of the work. The paper was very fully discussed, and the general opinion was that on the whole much valuable work had been done in training the unemployed of London for agricultural and garden work, although some of the speakers criticised those results and animadverted upon the cost at which they had been attained.

Mr. Archibald Colquhoun's paper on "Bosnia and Herzegovina" also gave rise to a rather animated discussion, in which very various views were expressed by speakers, representing some of the nationalities concerned. All, however, who took part in that discussion, realised the value of the information supplied by Mr. Colquhoun about a country, which, though now a centre of very great interest, is not familiarly known to many English travellers.

During the last few years, the Society has been singularly fortunate in securing the assistance of eminent Frenchmen in contributing to its Proceedings. In the Session of 1906-7, Monsieur Bunau-Varilla gave a most valuable paper on the Panama Canal, advocating the view, which, though it has not commended itself to the United States Government, has yet many who approve of it, that it would be better to cut a canal across the Isthmus at sea level, rather than to carry out the work in the form of the original scheme of a canal with locks. Last session, Monsieur Lucien Hubert gave the Society an account of the French system of colonisation, which, though it is entirely different from the English idea, yet offers many suggestions of importance. During the session which has just concluded, Monsieur Yves Guyot, the distinguished French economist, read an important paper on "The Commercial Relations of France and Great Britain." The principal point with which Monsieur Guyot dealt, was the probable effect upon international commerce of the

recently proposed modifications in the French Tariff. The chairman, Sir Robert Giffen, was hardly prepared to agree fully with the disastrous anticipations of Monsieur Guyot, but other speakers, especially Mr. Harold Cox, supported him, and thought that all possible pressure should be brought upon the French Government to prevent the carrying into effect on the lines proposed of the new tariff.

At the next meeting Mr. Clayton Beadle and Mr. Henry P. Stevens gave an account, mainly historical, of the manufacture of Hand-made Papers in different periods. Following this, at the first meeting in March, Mr. George Hubbard, in a paper on Dew-ponds, urged the importance of the utilisation of the application of what might be called the dew-pond system to the obtainment of water in arid countries. The paper gave rise to a great amount of discussion, both in the *Journal* and elsewhere, discussion which seems hardly yet to be concluded. The precise means by which a pond on the top of a high down, into which no surface drainage can flow, is kept full cannot yet be said to be absolutely settled, though it is difficult to imagine any other source than condensation of atmospheric moisture, whether in the form of what is known as dew, or from mist or fog. At all events there can be no doubt that the suggestions made by Mr. Hubbard as to the carrying out of experiments in rainless districts are well worthy of consideration, and that if even a moderate supply of water can be obtained by such means, the result will be of very great value indeed.

In the year 1897, in his course of Cantor Lectures on "Alloys," the late Sir William Roberts-Austen first brought under the notice of the Society the then novel method of investigating the structure of metals and alloys by a microscopic examination of their etched surfaces. Mr. Walter Rosenhain, to whose labours at the National Physical Laboratory much of the advance during recent years in this subject is due, told the Society in his paper on "The Application of the Microscope to the Study of Metals" how great those advances had been, and showed how important the power of examining the structure of such materials as commercial steel had proved, enabling as it did metallurgists to detect, and consequently eliminate, impurities in such articles as girders, crank-shafts, boiler tubes and rails, impurities which might eventually prove to be the cause of fracture.

By most people, even qualified musicians, the drum has always been looked upon rather as an instrument for marking and emphasising time rather than for the production of melody. The object of Mr. Gabriel Cleather's paper on "The Musical Aspect of Drums" was to controvert this view, and to prove, as he certainly did by his paper and by the illustrations with which he supplemented it, to those attending the meeting that the drum was in every sense a musical instrument, whose value for orchestral effects was far greater than was generally admitted.

For some years past a great deal of attention has been directed at the Society's meetings to the question of Timber Supply, and in the papers read in recent sessions by Sir Wilhelm Schlich, Sir Herbert Maxwell, General Michael, and Mr. Hutchings, the question has been very fully treated from different points of view. Dr. Nisbet's paper on "Afforestation and Timber Planting in Great Britain and Ireland" was, in the main, a criticism on the proposals for timber planting on a large scale included by the Royal Commission on Coast Erosion in their Report. At the same time, Dr. Nisbet was strongly in favour of a reasonable scheme of afforestation, provided sufficient attention was given to the conditions and requirements of the different parts of the country. In the discussion which followed, Dr. Nisbet's remarks on the Report were to a great extent endorsed, although there was, as might naturally be expected, some divergence of opinion as to the steps which should be taken for increasing the timber supply of this country.

Special attention has lately been directed to the island of St. Helena in consequence of the removal of the garrison from the island, and the disastrous effect which that removal is having upon its prosperity. Mr. J. C. Melliss, who is well known as having devoted a great deal of attention to the history and conditions of the island, gave the Society a very interesting account of it in the paper which he read here and urged the necessity of some steps being taken to revive its decaying fortunes, and to remedy the effects caused by the removal of the garrison.

In his paper on "The Resources of the Peruvian Andes and the Amazon," Mr. C. Reginald Enock may be said to have continued the subject which had been started at the beginning of the Session by Sir Martin Conway, the mineral and industrial resources of Western South America. Mr. Enock, who has already made a name for himself by th

valuable works which he has written on Peru, gave a very full account of the mineral and other resources which are now being worked in the district under consideration, and still await further development.

Mr. Percy Wells discussed in his paper on English Furniture the condition and prospects of the present manufacture of furniture in this country. He maintained that our designers and craftsmen were as capable now as in any previous era, but pointed out that the trade had to adapt itself to the changed conditions of modern production, in which of necessity machinery played a large part. Illustrating his remarks by a large collection of photographs of modern furniture, shown upon the screen, he demonstrated the excellence of the work which was now being produced by a number of manufacturers, both in the highest and most costly style of furniture, and in cheaper and simpler, but still excellent, cabinet-work.

The next meeting was devoted to the second Aldred Lecture. The conditions under which these lectures are given are stated in another paragraph of the Report. It is to be remembered that under the conditions of the Trust the subjects of the lectures are to be either scientific or literary. In the Aldred Lecture delivered last May Dr. Arthur Dendy, Professor of Zoology in King's College, London, gave a brilliant exposition of the Mendelian theory, and of the principles of heredity in their practical application to the production of new forms of plants and animals. The subject is by no means an easy one to make clear to a popular audience, but, difficult as it was, Professor Dendy certainly succeeded in his attempt within the space of an hour's lecture, to explain a scientific problem of very great interest and very great practical importance.

Considerable attention has lately been directed to the question of Railway Development in China, and Mr. Arthur Barry in his paper on that subject rendered a public service by the very full account he gave of the history and present condition of railways in that country. That railways will eventually be both constructed and worked by Chinese engineers and officials appears to be certain, but Mr. Barry's experience led him to believe that the time for this had not yet arrived, and that China must for some time to come be content to employ foreigners, both for the construction and the management of her railways.

The last paper of the Session dealt with a subject of very great economic importance and scientific interest. When Sir William Crookes, at the meeting of the British Association in 1898, suggested that before very long we should have to rely upon atmospheric nitrogen to supply the nitrates required for agricultural purposes, even his great reputation hardly prevented the suggestion from being treated as visionary. But there seems now very little doubt that Sir William Crookes' ideas are actually being realised at the present time. Herr Sam Eyde, who read to a large and interested audience on the 26th of May a paper on "The Manufacture of Nitrates from the Atmosphere," described the process which he and his partner, Professor Birkeland, have devised for obtaining nitric acid from atmospheric nitrogen by means of an enormous electric arc, and utilising that nitric acid for the manufacture of nitrates available as fertilizers. There seems no reason to doubt that the nitrate of lime produced by this method can compete both in manurial value, and in price, with the natural nitrate of soda, or the artificial sulphate of ammonia, which are now the fertilizing agents from which is supplied the nitrogen required by growing crops. The importance of the discovery it is difficult to overestimate, provided of course that further experiments on a commercial scale confirm the anticipations now held forth by the inventors.

II.—Indian Section.

The programme consisted of six papers, viz., "The Function of Schools of Art in India," by Mr. Cecil L. Burns; "The Birds of India," by Mr. Douglas Dewar, I.C.S.; "The Problem of Indian Labour Supply," by Mr. Selwyn Howe Fremantle, I.C.S.; "Some Phases of Hinduism," by Mr. Krishna Govinda Gupta; "The Buddhist and Hindu Architecture of India," by Professor Arthur Anthony Macdonell, Ph.D., and "Native Man in Southern India," by Mr. Edgar Thurston. With a single exception, all the above-mentioned contributors are actual members of the public service, and of these three are at home on furlough. Another has come to England on special duty, and the fifth is one of the two distinguished Indian gentlemen recently added to the Secretary of State's Council.

Mr. Dewar dealt in the first place with the general characteristics of the rich and interesting avifauna of the peninsula. He then devoted some time to various special features of Indian ornithology and to the consideration of certain phenomena which he maintains prove that "Wallaceism"

or the neo-Darwinian position is untenable. Finally, he referred to the depredations of the plume-hunter. During the Viceroyalty of Lord Curzon, an Act was passed prohibiting the export of plumage other than ostrich feathers, except as natural history specimens for museums. It is said, however, that the law is systematically evaded, and that the following Indian birds have recently been on sale in the London market:—Egrets (the "ospreys" of the feather trade), Impeyan or monal pheasants, paroquets, kingfishers, trogons, orioles, rollers, pittas, owls, jungle and peafowl, all (excluding the paroquets) "good friends of the Indian ryot." There is now before Parliament a Bill to prevent the importation of plumage into the United Kingdom, and if this measure is passed the Indian Act will probably be rendered more effective.

Professor Macdonell lately made a lengthened and important tour in India for the purpose of exploring the archæological remains of that country. His valuable paper embodied the main results of his examination of all the more distinctive of these ancient monuments, some of which are distant from the beaten tracks, and seldom visited by European savants. Professor Macdonell had many opportunities of seeing the beneficial effects of the much-needed Ancient Monuments Preservation Act, which India owes to Lord Curzon. One of the buildings which that Act is intended to conserve has a corridor in extent second only to that in the Vatican and 700 feet long. On a single band of the frieze of another structure visited by Professor Macdonell is a procession of 2,000 elephants, no two of which exactly resemble each other. Professor Macdonell claims to have demonstrated in his paper that while the Hindu temple of Southern India has been evolved from the *viharas* (monasteries) of the Buddhists, the Hindu temple of Northern India, as well as Buddhist temple architecture outside India, is a development of the *stupa* (relic mound).

Mr. Gupta began his singularly interesting paper by quoting some figures which, as he remarked, bring into prominent relief the important position occupied by the Hindus among the peoples of India, "an importance which is based not merely on their numerical superiority, but also on their material and intellectual progress." The population of the Indian continent is 294,000,000, and by religions it includes over 207,000,000 Hindus, 70 per cent. of the total. But Hinduism does not keep pace with its powerful rival, Islam, and would show an absolute decline in numbers but for large accessions of Animists. *Inter alia*, Mr. Gupta touched upon the social condition of the women of India, regarding whom, he says, there exists a great deal of misconception. It is asserted that they are immured within the walls of the zenana, where they spend their time in idleness and inanity. No picture could, he declared, be further from the truth. As regards the masses, constituting the bulk of the Hindu community, the women in most parts of India are as free as their sisters in Europe. Even among the better classes the zenana system is lax with the Hindus in Madras and Bombay; but whether the movements of Hindu ladies are restricted or not, they exercise an influence in family affairs which is far greater than is known here. With regard to the two great communities that seek to restore Hinduism to its original purity,—the *Brahma Samaj* and the *Arya Samaj*—flourishing branches of the former are now to be found in all parts of the country, and its adherents include some of India's most cultured and influential men. The *Arya Samaj*, though it has taken deep root in the Punjab is, however, still practically unknown in Bengal, Madras, and Bombay. "People in this country," Mr. Gupta says, "hear only of political unrest and of its various manifestations. They take little heed of the great religious upheaval that has overtaken the Hindu world, and of the various agencies that are at work for bringing about spiritual reform. From the earliest times the Hindu mind has been specially prone to religious impulses, and a Hindu above all is spiritual. His everyday life is mixed up with religion, and his care is more for the next world than for this. Hinduism is passing through a crisis which may well be described as severe, and it remains to be seen how far its powers of adaptation and assimilation, which have stood it in such good stead in the past, will come again to its help, and in what form it will ultimately emerge." Whatever happens, he holds that the descendants of so spiritual a race cannot drift into scepticism or irreligion. He hopes that the unsettling of beliefs caused by contact with the West will only be temporary, and that in future the religion of the Hindus will be "purged of all superstitious excrescences, and contain not only what is best in their own ancient faith, but also such precious gifts as the other noble

creeds have to offer, and that exclusiveness will give place to a wider sympathy and a truer recognition of the brotherhood of man."

Mr. Thurston's vivid account of the ethnographic investigations he has so successfully pursued in Southern India during the past eight years contained many new and interesting facts, especially with reference to the more backward tribes to be found in the Madras Presidency and neighbouring States. One of these tribes, the Pulayans, are, he says, the "most unpromising specimens of dejected humanity" whom he has come across, but civilisation "is fast bringing about changes in manners and customs which are sad from the ethnographist's point of view." Mr. Thurston expresses entire sympathy with the demand that selected candidates for the Indian Service should be required to take a course of study in the ethnology, sociology, and religion of the races among whom their life-work will lie.

In India, notwithstanding the density of the population—167 to the square mile—and the comparatively small number of large industries, the supply of efficient labour is not always equal to the demand. Not very long ago the attention of Government was urgently called to the matter by a Conference of Chambers of Commerce. In consequence of these and similar representations, Mr. Fremantle and another official were commissioned to visit the industrial and commercial centres of Bengal and Upper India to inquire into the causes of the scarcity complained of. It is chiefly from the experience gained in that inquiry, and from the discussions in which it resulted that the conclusions set forth in Mr. Fremantle's paper were formed. The normal growth of the population should be, in Mr. Fremantle's opinion, sufficient to provide all the labour required in the future, and recent improvements in communication have facilitated migration from the congested districts to the great industrial centres. Temporary difficulties may arise, but the Indian worker is tractable, teachable, and adaptable, and no fear need be felt that, "given fair conditions of labour and sympathetic treatment," there will ever be a serious shortage of labour in any field of industry. Coolie emigration, Mr. Fremantle showed to be, as far as the labour problem is concerned, a negligible quantity. British colonies, including Ceylon, contain nearly two million inhabitants of Indian nationality. But the average number of emigrants is now only 16,000 per annum, while about 9,000 return to India each year.

The experience of Mr. Cecil Burns, as Principal of the Bombay School of Art, has led him "slowly and unwillingly to the conclusion that although the artistic capacity of the people of India is present, the ancient craftwork of India is as dead as the art of the Greeks, or as that of the Renaissance in Europe." In his opinion, India must do for her artistic industries what Europe did long ago for hers and what Japan has recently done—transform them from an aggregation of isolated craftsmen to organised and skilfully directed combinations of workmen. With this end in view he urges the establishment by Government of a properly equipped central institution in which decorative work for public buildings can be designed and made. By this means the link which is missing in the educational chain that should join the Art School to practical craftwork would be supplied, a better standard of decorative work ensured, and a stimulus given to private enterprise in a field hitherto neglected by capitalists.

III.—Colonial Section.

"The Production of Wheat in the British Empire" was the subject of an important paper read by Mr. Albert E. Humphries, at the opening meeting of the Section, the President of the Board of Agriculture, Lord Carrington, occupying the chair. Mr. Humphries dealt exhaustively with the position and prospects of wheat cultivation in the United Kingdom, Australasia, Canada, India, and British Africa; discussed the "Rust Problem" in the light of his experiences as Chairman of the Home Grown Wheat Committee, and of the remarkable discoveries that Prof. Biffen has made at Cambridge by applying Mendelian principles to the greatest of the cereals, and concluded with some suggestive remarks on the effect of price on production.

Mr. J. Obed Smith in his comprehensive paper on "Canada as a Field for British Investment and Settlement" submitted that capital already invested in our North American possessions is safe and profitable; that the Dominion will continue to open up opportunies of securing investment for more capital; that the immigration of large numbers of new settlers, with small or large capital, is changing the economic conditions of the country, making investments more necessary, and, therefore, more secure; that American capital — and on this he laid stress—is seeking to control Canadian

industries; that there is more than a possibility of shipping Canadian grain, with profit, *viâ* Pacific ports to Great Britain; and that the probability of augmented commerce on the Pacific Ocean will attract capital, and warrant serious consideration. Mr. Smith expressed surprise that British capitalists should continue to be so largely interested in American railways and similar ventures when, owing to the limitations of the wheat-growing area in the United States, railway enterprise must to some extent be checked in the near future; while, on the other hand, railway construction in Canada "is not yet one-fifth of what will be required to develop Canada's resources to an extent equal to those in the States." In this connection he also mentioned that during the year 1908 the American Republic lost more people by emigration than it received by immigration. The chairman of the meeting, Lord Hindlip, observed that if any one believes that Canada is borrowing too fast or asking for more money than she can put up collateral security for, he had better go and see for himself. Those who have not been in Canada recently can, he added, form no conception of the progress that is being made every year and indeed every month. One of several Canadian visitors, who contributed to a useful discussion, warmly acknowledged the debt of gratitude which he said is owing to the Society for the opportunities it affords to people at home to realise the resources of the Empire.

In his valuable paper on "The Road to South African Union," the Hon. Charles Gideon Murray, of the Colonial Service, reviewed the various steps that have culminated in the present movement for unification, and showed how physical conditions have, despite all the influences tending to produce unrest and disunion, gradually compelled the people of South Africa to combine for their common benefit. With regard to the racial question between Boer and Briton, Mr. Murray thinks that it will be solved both by fusion of the two races and by an influx of immigrants of various nationalities. Interesting comments on the paper were made by Sir Godfrey Lagden, who presided, the Hon. Sir Lewis Michell, one of the members of the recent Conference which drew up the draft Act of Union, the Hon. Sir J. Liege Hulett of Natal, and others.

Nobody who heard or has read Mr. John Ferguson's admirable account of the splendid material and moral progress of Ceylon will be at all disposed to question the claim of the people of that fertile, beautiful, and enterprising island to be regarded as the leading Crown colony. It has now a population of 4,000,000; when it became a British possession there were less than a million inhabitants. At that time there were no roads worthy of the name; at present there are 3,000 miles of metalled, and 1,000 of gravelled roads, as good as are to be found in any part of the world. The record is, perhaps, less satisfactory with respect to railways, but that is owing apparently to what is considered by the planting community as the excessive caution of the authorities. The Colonial Office is now being pressed to sanction further lines, and Mr. Ferguson, as well as Sir West Ridgeway, who presided, strongly urged that the existing surplus of two million rupees should be used for this purpose rather than invested, as the Secretary of State has proposed, to form a reserve in case of some future and, as it is contended, extremely unlikely catastrophe, such as the ruin of the coffee industry by leaf disease a generation ago. The anticipated enormous increase, at a comparatively early date, in the value of Ceylon's rubber output, was advanced by Mr. Ferguson as one of the reasons why "Downing-street" should not delay any pressing schemes of railway and road extension.

IV.—Applied Art Section.

After very careful consideration, the Council determined in November last that the interests of the Society would in no way suffer if the Applied Art Section as a separate division of the Society was abolished, and its work merged in the general work of the Society.

The Section of Applied Art was established in 1887, and every Session since that date from four to six papers have been read dealing with subjects coming more or less within the scope of the application of Art to Industry. The definition has always been construed rather liberally, and the Section has been made to include papers dealing with artistic matters generally, as well as with Industrial Art. On the whole there can be no doubt that the contributions which the Society has received in this Section have included many most valuable and useful papers, and it is hoped that equally valuable papers will be read in future at the Ordinary Meetings of the Society, as indeed they were before the establishment of the Section. Since its establishment the Section has benefited by the

services of Mr. Wheatley as its Secretary, and his leaving the service of the Society offered a convenient occasion for the alteration.

V.—Cantor Lectures.

The Society has been fortunate in having a more than usually brilliant series of Cantor Lectures this year. The first course was on Explosives, by Mr. Oscar Guttmann, who is recognised as one of the highest authorities, at all events in this country, on the subject. Mr. Guttmann dealt with the progress which has been made in the manufacture during the past twenty years, and treated as fully as was possible in the course of four lectures the methods of manufacture of the various classes of explosives, and their several applications. Not the least interesting of the lectures was the one in which the use of explosives in mines was treated.

In the first course after Christmas, Mr. G. L. Addenbrooke dealt with the general question of Electric Power Supply, its cost, methods, and legal position. These lectures attracted a great deal of attention at the time of their delivery, and the suggestions made by Mr. Addenbrooke will certainly have to be considered in any future legislation on the subject.

In the third course, Mr. Leon Gaster dwelt with the whole question of Artificial Illumination, whether by electricity, gas, oil, or other illuminants. Perhaps no course ever given before the Society was so fully and elaborately illustrated. Mr. Gaster was able to secure typical examples of all the various methods of lighting which he described, and in fact each lecture was a concentrated exhibition of the best and most recent apparatus used for lighting by electricity, gas, and petroleum.

In the fourth course Mr. Gerald Stoney, who has been intimately associated with the firm of Messrs. Parsons in the construction and introduction of steam turbines, gave a most interesting account of the history of the Turbine from its origin down to its latest developments.

The fifth, and last, course was by Mr. F. W. Lanchester on Aerial Flight. There is perhaps no one who has made a more elaborate and careful study of the theory of the question than Mr. Lanchester, while his experience as an engineer and constructor of motors enabled him to deal fully with the practical side of the subject as well as the theoretical.

VI.—Juvenile Lectures.

In the long list of subjects which have been dealt with in the Juvenile Lectures since the first course was delivered here in 1874 by the late Frank Buckland, many topics have been brought before the Society, but nearly all dealt with some branch of science, or its practical application. This year the Council broke new ground by inviting Professor Waldstein to lecture on an archæological subject, and his two lectures on "Digging for Ancient Art Treasures," fully justified the experiment. Professor Waldstein gave a clear and graphic account of the methods which were pursued in investigating historic and prehistoric sites, and indicated briefly how great had been the effect on our knowledge of early history, which had been brought about by the investigations of himself and his colleagues.

VII.—Aldred Lecture.

The establishment of a series of lectures bearing this title was the outcome of a bequest by Dr. George William Aldred, a member of the Society, who died in 1868. He served with Her Majesty's army in India, graduated as M.D. of Paris in 1841, became a member of the Royal College of Surgeons in 1843, and was made a Fellow in 1859. At the time of his death he was resident in London. He bequeathed nearly all his property to public charities, mostly medical. Among his bequests he left a sum of £100 to the Society of Arts, in order that the interest might provide annually a £5 prize for an essay on some scientific or literary subject. The actual amount of the bequest (£90) was invested in Reduced Three per Cents—£97 16s. 6d. The interest on this was obviously insufficient to provide an annual prize of £5, and the Council consequently determined, in 1883, to allow the money to accumulate until there was sufficient to provide an annual sum of £5.

The total amount invested is now £220, which gives an annual income of over £6. Last year the Council determined that it could be more usefully employed in offering a fee for a lecture than a prize for an essay, while at the same time the presumed wishes of the testator would be carried into effect. They accordingly invited Sir William Ramsay to give the Society some information on his recent researches on radio-activity, and the brilliant lecture on "A Radio-Active Gas" delivered in December, 1908, was the result.

Wishing to vary the subject as much as

possible, they thought that this year they would endeavour to provide a discourse of a biological nature, and they were fortunate in securing the help of Professor Dendy, who in April lectured to the Society on "The Principles of Heredity as Applied to the Artificial Production of new forms of Plants and Animals." A reference to the contents of the lecture will be found in the portion of this report dealing with the Ordinary Wednesday evening meetings, at one of which it was delivered.

The Council hope that they may be able to continue the series of Aldred lectures either annually or biennially, as the funds may permit.

VIII.—Albert Medal.

The Council of the Society, with the approval of His Royal Highness the President, have awarded the Albert Medal of the Society for the current year to Sir Andrew Noble, Bart., K.C.B., D.Sc., D.C.L., F.R.S., "in recognition of his long-continued and valuable researches into the nature and action of explosives, which have resulted in the great development and improvement of modern ordnance."

As far back as 1858 Sir Andrew Noble, then a Captain in the Royal Artillery, served as Secretary of the Committee on Rifled Cannon, and in the following year as Secretary of the Committee on Armour Plate and Guns. He had also become a War Office Inspector of Artillery when, in 1860, he joined Sir William Armstrong in the great Elswick firm, his connection with which has continued up to the present time. He has therefore very nearly completed half a century's work in association with the firm, and all that long time has been devoted to the investigation and improvement of the science of artillery. A great deal of this work was undertaken in collaboration with the late Sir Frederick Abel, but a great deal more of it was personal and original. The experiments which Sir Andrew Noble has carried out have ranged over every phase of the application of the science of artillery, practical, mathematical, chemical, physical, and historical. In his own words,* he has been associated "with all the great changes which have taken place, both as regards the guns, their mountings, equipments, and propellants, from the introduction of rifled artillery." His experiments include the firing of many thousands of rounds of artillery, and thousands of rounds in closed explosion vessels. They have dealt with the subject of pressures, velocities, and times, in the bores of guns and in closed vessels, also with the temperatures, composition, and decomposition of the gases, erosions, and detonations, as well as the chemical and practical examination of propellants and explosives of many kinds, and used by various nations.

To him is due the construction and use of the Chronoscope, the observations from which follow the motion of the projectile from the commencement of its motion to its leaving the bore of the gun. To his investigations are also due the arrangement and use of the Crusher gauge for recording the gaseous pressures during the passage of the projectile along the bore of the gun.

As a result of his experiments, makers of ordnance now possess chemical analyses and graphic illustrations, which provide a complete theory of ballistics, and indicate the chemical and dynamic action of the explosive during the period of its combustion. The whole theory of slow burning powder, by the action of which the pressure of the explosive is gradually increased, is due to the long series of experiments, the nature of which has been briefly summarised.

As long ago as 1877 the experiments of Sir Andrew Noble and Sir Frederick Abel caused an immediate reconstruction of guns and their mountings, and a return to breech-loading for British guns from the retrograde change to muzzle-loading which had some years before been adopted. From that date to the present time, all the many and great improvements which have been made in ordnance in this and in other countries, are to a very large extent due to the long series of experimental researches, carried out with persevering energy and unfailing ability by Sir Andrew Noble.

IX.—Medals.

The Council have awarded the Society's Silver Medal to the following readers of Papers during the Session 1908-9:—

At the Ordinary Meetings:—

To Mr. G. Albert Smith, for his paper on "Kinematography in Natural Colours."

To Mr. Henry C. Brewer, for his paper on "Gothic Art in Spain."

To Monsieur Yves Guyot, for his paper on "The Commercial Relations of France and Great Britain."

To Mr. George Hubbard, for his paper on "Dew-ponds."

* Preface to "Artillery and Explosives."

To Mr. WALTER ROSENHAIN, for his paper on "The Application of the Microscope to the Study of Metals."

To Mr. GABRIEL GORDON CLEATHER, for his paper on "The Musical Aspect of Drums."

To Mr. C. REGINALD ENOCK, for his paper on "The Resources of the Peruvian Andes and the Amazon."

To Mr. PERCY A. WELLS, for his paper on "English Furniture Design and Construction."

To Mr. ARTHUR JOHN BARRY, for his paper on "Railway Development in China."

To Herr SAM EYDE, for his paper on "The Manufacture of Nitrates from the Atmosphere by the Electric Arc."

In the Indian Section :—

To Mr. DOUGLAS DEWAR, for his paper on "The Birds of India."

To Mr. ARTHUR ANTHONY MACDONELL (Boden Professor of Sanskrit, Oxford), for his paper on "The Buddhist and Hindu Architecture of India.'

To Mr. SELWYN HOWE FREMANTLE, for his paper on "The Problem of Indian Labour Supply."

To Mr. KRISHNA GOVINDA GUPTA (Member of the Council of India), for his paper on "Some Phases of Hinduism."

To Mr. CECIL L. BURNS (Principal, Bombay School of Art), for his paper on "The Functions of Schools of Art in India."

In the Colonial Section .—

To the HON. CHARLES GIDEON MURRAY, for his paper on "The Road to South African Union."

Of recent years it has been the practice that no medals should be awarded to readers of papers who had previously received medals from the Society. Acting on this rule the Council were precluded from considering the following papers :—In the Ordinary Meetings the papers by Sir W. Martin Conway, on "The Goldfields of Eastern Peru and Bolivia," and by Mr. Archibald R. Colquhoun, on "Bosnia and Herzegovina;" in the Colonial Section, the papers by Mr. Albert E. Humphries, on "The Production of Wheat in the British Empire," and by Mr. John Ferguson, C.M.G., on "Ceylon: its Industries and Material Progress."

The Council, however, desire to express their high appreciation of these papers by thanking their authors for them.

The brilliant lecture delivered, under the Aldred Trust, by Professor Dendy, was not considered to be eligible for a Medal, though it occupied one of the Ordinary Meetings.

X.—SWINEY PRIZE.

In accordance with the provisions of the will of Dr. George Swiney, the prize bearing his name was duly awarded in January last, on the sixty-fifth anniversary of the testator's death. Dr. Swiney died on the 20th January, 1844, and in his will he left the sum of £5,000 Consols to the Society of Arts, for the purpose of presenting a prize, on every fifth anniversary of his death, to the author of the best published work on Jurisprudence. The prize was to be a cup of the value of £100, and money to the same amount; the award to be made jointly by the Royal Society of Arts and the Royal College of Physicians.

A meeting of the adjudicators of the prize was held on Wednesday, January 20, 1909, under the presidency of Sir William White, K.C.B., F.R.S., Chairman of the Council.

The adjudicators received a report from the joint Committee of the Society of Arts and the College of Physicians, recommending that the prize should be awarded to Dr. Charles Mercier, for his book, "Criminal Responsibility," and they adjudged the prize in accordance with the recommendation.

Under the existing understanding between the College and the Society, the Prize is given alternately to a work on General Jurisprudence, and to one on Medical Jurisprudence.*

XI.—OWEN JONES PRIZES.

After the death, in 1874, of Owen Jones, a committee was formed to collect subscriptions for the purpose of founding a memorial, and the balance (a sum of £400) was presented to the Council of the Society of Arts upon condition of their expending the interest thereof in prizes to "Students of the Schools of Art who, in actual competition, produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones." The prizes have now been awarded annually since the year 1878 on the results of the annual competition of the Science and Art Department, and its successor, the Board of Education.

Six prizes were awarded last session (1907-8), each prize consisting, in accordance with the regulations prescribed for the administration of

* A list of previous recipients was given in the *Journal* of November 27th, 1908. Such information as is available about Dr. Swiney and his life will be found in two articles in the *Journal* of June 23rd, 1899, and April 16th, 1909. An account of the cup was published in the *Journal* on the last-named date, and an illustration appeared in the issue of June 24th, 1904.

the Trust, of a bound copy of Owen Jones's "Principles of Design," and a Bronze Medal.

The list of the successful candidates has already appeared in the *Journal*.*

XII.—Mulready Prize.

After the death of Mulready, in 1863, a fund was formed to establish a memorial to him. Sir Henry Cole was treasurer of this fund. The greater part of it was expended in erecting a monument over Mulready's grave in Kensal-green Cemetery. This monument is in the charge of the Society, and from time to time small sums have been expended on its cleaning and restoration. The balance, £109, was presented to the Society of Arts with the view of a Mulready Medal being presented occasionally to the student who should exhibit the best drawing from the nude at the annual examinations of the Science and Art Department, now the Board of Education.

The Medal has been awarded on several occasions, the last being in 1903. In April, 1907, it was announced in the *Journal* that a gold medal, or a prize of £20, would be offered for competition among students of Schools of Art in the United Kingdom, at the annual competition of last year.

The award was duly made on the recommendation of the Examiners of the Board, and was announced in the *Journal* last October.†

XIII.—Stock Prize.

In 1871 John Stock left £100 Consols to the Society, with the condition that the interest should be applied for the promotion of drawing, sculpture, and architecture. From time to time, as the accumulated funds permitted, prizes have been awarded under the Trust. In 1893, and again in 1897 prizes were offered to students in Schools of Art for architectural designs. A Gold Medal, or a prize of £20, was again offered for competition among the students of the Schools of Art at the annual competition of 1908 for "the best original designs for an architectural decoration, to be carried out in painting, stucco, carving, mosaic, or any other process suitable for the side of a room or a hall, a ceiling, the apse or side of the chancel of a church, or part of the interior of a building."

The award, which was made on the recommendation of the examiners of the Board of Education, was announced in the *Journal* in September last.*

XIV.—Fothergill Prize.

In the year 1907, the Council decided to offer under the Fothergill Trust, a Gold Medal, or a prize of £20, for the best portable apparatus or appliance for enabling men to undertake rescue work in mines or other places where the air is noxious, the object being to encourage the production of a rescue apparatus which would enable a succouring party to reach men cut off—in case of mining accidents—by irrespirable gases, or suffocated by them. It was known that many such appliances existed, but it appeared uncertain which of them were the best, or even which were of practical use.

In response to the offer a number of appliances were submitted by the specified date (March, 1908), and the Council appointed a Committee to deal with them. It was intended that all the apparatus sent in should be submitted to practical trials, but it was hoped that this might be done and the award made without any very great delay. It turned out, however, that a large experimental gallery, with the use of which the Council had hoped to be favoured, was not ready and indeed is not yet available, and the Council have, therefore, reluctantly been compelled to postpone the contemplated trials. The delay is, however, less to be regretted, because on the one hand there have been recent rapid improvements in details of the various apparatus which it is very desirable, if possible, to take into account, and on the other there has been a considerable increase of knowledge as regards the points of greatest importance in the apparatus.

XV.—North London Exhibition Trust.

In 1865 the Committee of the North London Working Classes and Industrial Exhibition (1864) presented to the Society a sum of £157, the balance of the surplus from that Exhibition, with a view to the annual award of prizes for the best specimens of skilled workmanship exhibited at the Art Workmanship Competitions of the Society. These competitions were discontinued after 1870, but since that date various prizes have been awarded under this Trust. In 1903 it was found that the funds had accumulated, and accordingly it was determined to make a special offer of prizes of the value of Fourteen

* See *Journal*, vol. lvi., p. 915, 9 Sept., 1908.

† See *Journal*, vol. lvi., p. 1013, 23 October, 1908.

* See *Journal*, vol. lvi., p. 929, 11 September, 1908.

Guineas to the students of the Artistic Crafts Department of the Northampton Institute, Clerkenwell. These prizes were continued annually to 1908. As by that time the accumulation was nearly exhausted, the Governing Body of the Institute were offered the choice between annual prizes of smaller value, and occasional prizes of the amount above mentioned. They selected the former, and therefore a sum of £5 will be annually devoted to the purpose until further notice. Prizes of that value were accordingly offered and awarded for the current year.

The results of the award were published in the *Journal* last April.*

XVI.—Prizes for Drawing.

Since 1889, the Council have annually placed at the disposal of the Royal Drawing Society, for competition among the candidates at its annual examination, 12 Bronze Medals, and these medals were awarded for drawings sent in by students to the exhibition held by the Drawing Society in April last.

Though these medals have been provided now for a period of twenty-one years, it must not be understood that the offer is certain to be continued. The question has been under the consideration of the Council, and notice has been given to the Royal Drawing Society that the award of medals may be discontinued at any time, the offer being only an annual one.

XVII.—Examinations.

As in recent years, it is proposed to postpone any detailed report on the year's examinations, until the results have all been issued. The Results of Stage III., Advanced, were published on June 17th. It is hoped to publish the results of Stage II., Intermediate, during July; and of Stage I., Elementary, early in August.

The total number of papers worked was 29,020, the number last year being 25,805, an increase of 3,215. These were divided among the various Stages as follows:—Stage I., 11,074; Stage II., 12,513; Stage III., 5,433. The corresponding figures for 1908 were—Stage I., 9,811; Stage II., 11,199; Stage III., 4,795. The increase is spread over all the Stages.

XVIII.—Viva Voce Examinations in Modern Languages.

Up to the present date 17 examinations have been held this year in London, Guernsey, Hitchin, and Manchester. Arrangements have also been made for holding examinations at several other centres.

At these examinations 366 candidates presented themselves, of whom 285 passed (96 with distinction) and 81 failed. The languages taken up were French, German, Italian, and Spanish.

The results of previous years are as follows:—

Year.	Number Examined.	Passed.	Failed.
1902	280	202	78
1903	456	324	132
1904	540	375	165
1905	681	502	179
1906	644	469	175
1907	629	476	153
1908	615	467	148

These examinations are held at any of the Society's centres where the necessary arrangements can be made, at any date convenient to the local committee. The examination includes dictation, reading, and conversation, and the examination is so arranged as to test efficiency in a colloquial knowledge of the language, without laying too much stress on minute grammatical accuracy. Candidates who are reported upon as highly qualified by the examiners, receive a certificate of having passed with distinction.

The examiners are Mr. S. Barlet for French, Professor H. G. Atkins for German, Professor R. Ramirez for Spanish, and Mr. Luigi Ricci for Italian.

The numbers this year, when all the examinations are finished, are not likely to show any considerable difference from those of 1908.

XIX.—Practical Examinations in Music, 1908.

The practical examinations in Music were not concluded last year until the 4th July, too late for the results to be included in the Report of the Council. They lasted for 10 days.

The examination was conducted by Dr. Ernest Walker, M.A., and Mr. Burnham Horner.

The system of examination was the same as that for recent years. For instrumental music certain standards are given, and candidates are asked to select for themselves which of these standards they choose to be examined in. The standards range from easy to very difficult music. For each standard a list of music is given for study, and from this

* See *Journal*, vol. lvii., p. 510, 24 April, 1909.

list candidates select the pieces they will sing or play. Candidates are expected to play or sing the pieces which they have prepared, to play or sing a piece, or portion of a piece, at sight, and to play certain scales.

In all, 440 candidates entered, and of these 432 were examined, a decrease of 25 as compared with the previous year. There were 333 passes and 99 failures.

The following were the subjects taken up:—Piano, singing, violin, violoncello, and viola. 330 entered for the piano, 243 of whom passed; 86 entered for the violin, of whom 76 passed; 2 entered and passed for the violoncello; 12 entered for singing, of whom 10 passed; and 2 entered and passed for the viola. Two medals were awarded.

XX.—Practical Examinations in Music, 1909.

The Practical Examinations for the present year have not yet been concluded. They commenced on the 22nd June, 1909. They will be finished on July 3rd, after which a summary of the results will be given in the *Journal*. The work of the examination is being carried out by the same examiners as in the last eight years. 400 candidates have entered for the present examinations, a decrease on last year of 40.

XXI.—Cobb Memorial Fund.

In the year 1901, after the death of Mr. B. Francis Cobb, who had served on the Council in various capacities since the year 1875, a fund was subscribed for the benefit of his widow, who was left in rather poor circumstances. It was arranged that at the death of Mrs. Cobb the portion of this fund which had been given by Members of the Society, or collected by its Secretary, should be returned to the Society of Arts to be dealt with as the Council might decide. The amounts contributed by Members of Lloyd's were in like manner to be passed on to Lloyd's Benevolent Fund. Mrs. Cobb died in March of the present year, and the Trustees of the Fund handed to the Society's Treasurers the amount of £248 17s. 4d., the proportion realised from the sale of the securities in which the money had been invested.

The Council, after careful consideration, decided that the money should be employed to establish a permanent memorial to Mr. Cobb, and that for the present it should be devoted to the establishment of an occasional lecture, or course of lectures—the disposition to be varied from time to time, as the Council might determine.

XXII.—Chadwick Trust.

Under the provisions of the will of Sir Edwin Chadwick, who died in 1890, the Royal Society of Arts nominates a member of the Trust established by Sir Edwin for certain purposes connected with sanitary education and the advancement of sanitary science. The Trust was formed in 1896, and Sir Douglas Galton was appointed to represent the Society of Arts. After the death of Sir Douglas Galton in 1899, Mr. Brudenell Carter acted as the Society's representative, and he was succeeded in 1904 by Sir William Abney, who was then Chairman of the Council. Sir William Abney's term of office having expired this year, the Council decided to appoint the Society's Secretary to act as its representative.

XXIII.—London Institution.

It will be remembered that in 1904 a proposition was made by the Board of Managers of the London Institution to the Council of the Society of Arts that a scheme for the amalgamation of the two bodies should be considered. A Joint Committee was appointed and a draft scheme proposed. This scheme was submitted to a meeting of the Proprietors of the Institution in the spring of 1905, but no vote was taken upon it, and no definite action followed. The Council of the Society therefore determined to abandon the idea so far as they were concerned, and discharged the Committee which they had appointed for its consideration.* In the latter part of last year the Board of Managers of the London Institution again took the question up, and decided to bring it for a second time before the Proprietors. No official communication on the subject was made by the Institution to the Society; but the Council of the Royal Society of Arts naturally regarded with benevolent interest the renewal of a suggestion which they always thought would be to the advantage of the individual members of the two bodies, and also to the public.

The first step taken by the Board of Managers was to recommend to the proprietors the scheme for amalgamation, and to ask their opinions by post-card. As the result of this enquiry, proprietors representing 526 shares expressed themselves in favour of the amal-

* See Reports of the Council, 1904-5 and 1905-6: *Journal*, 30th June, 1905, vol. liii., p. 847, and 29th June, 1906, vol. liv., p. 824.

gamation, and 84 were opposed. In February a special meeting of the proprietors was held, followed by a ballot. The result of the ballot showed 322 votes in favour, and 218 against. At the annual meeting of the Institution held in April, it was announced that the Royal Commission on University Education in London had intimated that they regarded the Institution as coming within the scope of their enquiries, and that, in the opinion of the legal adviser to the Institution, Parliament would not pass any Bill dealing with an Institution which was under the consideration of a Royal Commission. In these circumstances, no further action was taken, and the proposal was shelved for the second time.

At the Annual Meeting, as well as at the special meeting, a good deal of opposition was manifested on the ground that the amalgamation scheme would involve the removal of the Institution from within the City boundaries, and as the opposition seemed to show greater energy than the advocates of the change, it appears unlikely that, whatever the Commission may report, any proposal for amalgamation between the two Institutions will now be carried into effect. The Council cannot but regard with regret this abandonment of a scheme which promised to endow London with a powerful and well-to-do Institution by which the work, hitherto carried on by the two bodies for a century and a-half and a century respectively, might have been continued to their own greater advantage and with extended benefits to the country.

XXIV.—Honorary Royal Members.

In November last His Royal Highness the President of the Society, at the request of the Council, invited His Majesty the King of Sweden to become an Honorary Royal Member, a request to which His Majesty was pleased to accede. His Majesty's father—King Oscar of Sweden and Norway—was one of the first two Honorary Royal Members of the Society elected in 1876, His Majesty the King of the Belgians being the other.

XXV.—List of Members.

The number of life and subscribing members on the Society's books is 3,490, this includes a few Institutions in Union who subscribe from their own funds. The number of new members elected during the year was 280; the losses by death and resignation amounted to 355.

During the last forty years the number of the Society's members has not varied within very wide limits. In 1870 there were a little over 3,200; this rose in 1875 to 3,800. The numbers fell to 3,300 in 1881, and rose again to 3,656 in 1885. By 1899 the numbers had fallen to 3,078, rising again in 1900 to 3,123. After that there was a continuous increase up to 3,722 in 1906. Since that date the numbers have fallen away, and now, as above stated, the total is 3,490.

In 1850 the numbers were a little under 2,000. The increase in the twenty years succeeding 1850 was doubtless due principally to the great exhibitions of 1851 and 1862.

The number of Institutions in Union was much larger before the Examinations were thrown open. There are now in all only 18 Institutions in Union with the Society. Forty years ago there were about 150.

One feature in the present list is the large proportion of members residing in the colonies and in foreign countries. There are now few parts of the world in which the Society is not represented, while the number of Indian and Colonial members is very considerable.

XXVI.—New Council

The four Vice-Presidents who retire on account of seniority are Sir William Crooks, Mr. Robert Kaye Gray, Sir Philip Magnus, and Mr. Alexander Siemens. In their place the Council propose for election Sir Henry Hardinge Cunynghame, who, as an Ordinary Member of Council, has rendered the Society very active service, Lord Curzon, the Earl of Rosebery, and Lord Blyth, all of whom have served previously as Vice-Presidents.

The four Members of the Council retiring either from seniority or least attendances are Mr. Michael Carteighe, Sir Henry Cunynghame, Sir George Gibb, and Mr. H. Graham Harris. To fill the vacancies caused by these retirements, the Council suggest Dr. Henry Bovey, who, after many years service as a Professor and as Dean of the Faculty of Engineering at the McGill University, Montreal, has lately been appointed Rector of the Imperial College of Science and Technology; Mr. W. H. Davison, a Member of the London County Council Education Committee; Sir Robert Hadfield, a Past-President of the Iron and Steel Institute, and head of the well-known Sheffield firm to whom are due many of the recent improvements in steel manufacture; and Sir Richard Temple, who has contributed valuable papers on two occasions to the Society. None of these four gentlemen has ever served on the Council before.

XXVII.—CONVERSAZIONE.

The Conversazione for the present year was held on Tuesday last, the 29th inst., at the Natural History Museum, South Kensington, the Trustees of the British Museum having kindly granted this privilege to the Society. The last occasion, previous to 1908, on which the Conversazione was held at the Natural History Museum was in 1900, the Conversazioni from 1901 to 1907 having been held in the Gardens of the Royal Botanic Society. An account of the Conversazione for this year will be found in the present number of the *Journal*.*

XXVIII.—CHANGES IN THE STAFF.

Shortly after the close of the last Session Mr. H. B. Wheatley, who has been Assistant-Secretary of the Society since March, 1879, intimated to the Council his wish to retire, and in view of the length of his service and his time of life, the Council felt bound to accept his resignation, though they did so with very much regret. The Council were glad to secure the services of a capable successor to Mr. Wheatley in the person of Mr. G. K. Menzies, who has had considerable experience in the Central Office of the University of London.

Some of the present and past members of the Council of the Society subscribed for a testimonial to Mr. Wheatley, which took the shape of a piece of plate and a cheque, and was presented to him at the Council meeting on the 15th of March last by the Chairman of the Council, Sir William White, on behalf of the subscribers. Mr. Wheatley was also elected a life member of the Society under By-law 61, which empowers the Council to elect annually a certain number of life members free of all dues.

The finances of the Society, unfortunately, do not permit the Council to recognise the services of old and valued officials in their retirement; but, in the case of Mr. Wheatley, it was felt that a moderate pension should be voted to him.

XXIX.—OBITUARY.

It must be very many years since the Society has had to deplore the loss in a single year of so many of its members who were actively employed in carrying on its work. Since the last annual meeting the Council has lost no less than three of its most active members. Sir Charles Kennedy died in October, having been re-elected on the Council, after many years' previous service, at the last election. He was for ten years chairman of the Colonial Section, twice read papers before the Society, and was a regular attendant at the Society's various meetings. His great experience of commercial matters made him a very valuable member when the Council acted as the Royal Commission for the Chicago Exhibition in 1893. Dr. Francis Elgar had been a member of the Council from 1891, with an interval of two years, to 1909. Though his chief interests were concerned with the Institution of Naval Architects, t which he devoted much of his time and t which he bequeathed a large portion of hi money, he was an active and very valuabl member of the Society's Council. Sir Owe Tudor Burne had acted on the Council i every possible capacity, as an ordinar member, vice-president, treasurer and chair man, from 1887, with only the necessar intermissions, to the date of his death i February last. Though it was in the work c the Indian Section that he took the greates interest, he yet devoted himself zealously an with hearty goodwill at all times to any othe department of the Society's labours in whic he could be of service.

Besides those who actually died while o the Council, there are several other decease members who had at one time or other serve upon it. These are Sir Edward Birkbec Sir George Livesey, and the Hon. Dudle Fortescue, though it is many years since th last-named served on the Council, as he di at the great age of 89.

Sir Thomas Wardle read several valuab papers on silk manufacture. Mr. Bennett Brough gave the Society three courses Cantor lectures, and one course of Juveni lectures, all on subjects connected with minin He also read several valuable papers on mini subjects, for one of which he received t Society's silver medal. Mr. G. F. Deac long eminent as an authority on question water-supply, received a medal in 1882 for h paper on water waste and constant supply; also took an active part on various occasio in the Society's discussions. Sir Donald Cu was awarded the Fothergill gold medal of t Society in 1880 for improvements in passeng steamers, having for their object the preve tion of loss of life at sea. General Rund read two papers at the Society's ordin meetings, and one at the Canal Confer held in 1888. Sir George Barclay Bruce, t eminent engineer, took the chair at one of t meetings of the Indian Section in 1889.

* See p. 671.

Lord Blythswood, the Earl of Rosse, Lord Amherst of Hackney, and Earl Egerton were all members of the Society of long standing. Amongst other members of the Society who died during the past year should be mentioned Sir Thomas Brooke, Sir Edward Law, Mr. Henry Chapman, a well-known engineer, Mr. Andrew Pears, the head of the well-known firm of soap manufacturers, and Mr. Caesar Czarnikow. Notices of these, and of other members whom the Society has lost during the past year, will be found in the columns of the *Journal*.

XXX.—Finance.

The annual statement of receipts and expenditure was published—in accordance with the usual practice—in the *Journal* last week. It shows the revenue and expenditure for the financial year ending May 31st last, the Assets and Liabilities of the Society, its Investments and the Trusts standing in its name.

During the year the Council received an intimation from the executors of the late Mr. Robert Hannah, who was a member of the Society from 1864 to 1906, and died on April 5th, 1909, that he had bequeathed to the Society a sum of £100.

The Chairman (Sir William H. White), in moving the adoption of the Report, said that there was one point in it which struck him whilst it was being read. It was the practical constancy of the number of members during the past forty years, which seemed to him most remarkable. During that period there had been an enormous increase of population in the regions covered by the Society's operations, and while it was quite true that a large number of other societies, developed on parallel lines, had come into existence, he thought the Society ought to claim a much larger membership than it at present possessed, and that a larger revenue was necessary, if the Society was to do all the work it might do. He hoped the members would use every endeavour to attain this end. A promising opening for enlarged usefulness by amalgamation with the London Institution could not for the moment be taken advantage of, and whether such a union would take place in the future, it was impossible to say, but he felt sure that an increased membership, and an extension of the revenues of the Society, would be followed by very considerable results.

Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., seconded the adoption of the Report. He also wished to endorse the advice that Sir William White had given with regard to their membership. The regular expenses of the Society were becoming more and more every year, and he thought they should use every endeavour to make the Society better known. He was confident that members got their money's worth, and a good deal more, for there was an immense amount of information and literature to be found in the columns of the *Journal*, so that it was well worth subscribing for it alone, even if one was unable to be present at the meetings of the Society. He considered the papers and lectures delivered during the past session had been most admirable; they were full of information and instruction. He hoped the members would put their shoulders to the wheel, and do their best to increase the membership of the Society.

The adoption of the Report was then agreed to.

The Chairman moved a cordial vote of thanks to the Secretary and the other officers of the Society. Mr. Wheatley's retirement had been mentioned: he was sure all those who had the pleasure of knowing Mr. Wheatley, and his literary work, would realise the loss his retirement meant to the Society. They could, however, look back with every satisfaction at the manner in which his retirement had been dealt with, and he felt sure he was expressing the feeling of the members in conveying to Mr. Wheatley their very great regard for him and desire for his future happiness. He thought that in Mr. Menzies they had a successor to whom they could look for great help in the future. He had not come to them unproved for he had done exceedingly good work in connection with the University of London, and also as a literary man, and he hoped Mr. Menzies would be with them for many years to come.

Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D., in seconding the resolution, referred to the membership of the Society. He said it was to be remembered that the membership of the Society was not recruited, like many of the professional societies, from comparatively young men. Those who joined the Society were principally of middle-age, whilst a number joined after retirement from lengthened service in India and the Colonies, and consequently the mortality of the Society was much greater than in other cases. The Society, in his opinion, was one of the most living societies in the history of London, and it was not possible for the work to be carried on with greater industry and ability. At the same time, it view of the urgent necessity for providing additional accommodation for the Society, it was most desirable that there should be a steady increase in the number of members. As a former Chairman of the Indian Section, he would also like to mention the deep sense of obligation which he, as well as his predecessors and successors in that office, have always felt to Mr. Digby for the great earnestness he has shown in his work as Secretary of the Indian Section.

The SECRETARY, in returning thanks for this expression of confidence in himself and in the other officers of the Society, referred to the personal loss he had suffered from the retirement of Mr. Wheatley, who had worked under and with him in loyalty and friendship for over thirty years. He felt sure the members would be glad to know that Mr. Wheatley was quite happy in his retirement, as he was able to devote more of his time to his literary pursuits. They had found an admirable successor in Mr. Menzies, who was thoroughly capable of doing all the work which was likely to be put into his hands.

The ballot having remained open for one hour, and the Scrutineers having reported, the CHAIRMAN declared that the following had been elected to fill the several offices. The names in *italics* are those of members who have not, during the past year, filled the office to which they have been elected.

PRESIDENT.

H.R.H. The Prince of Wales, K.G.

VICE-PRESIDENTS.

H.R.H. The Duke of Connaught and Strathearn, K.G.
The Duke of Abercorn, K.G., C.B.
Sir William Abney, K.C.B., D.C.L., D.Sc., F.R.S.
The Lord Chief Justice, G.C.M.G., F.R.S.
Sir Steuart Colvin Bayley, K.C.S.I., C.I.E.
Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D.
Lord Blyth.
Sir William Bousfield, M.A., LL.D.
The Earl of Cromer, O.M., G.C.B., G.C.M.G., K.C.S.I., C.I.E.
Sir Henry Hardinge Cunynghame, K.C.B.
The Hon. Sir Charles W. Fremantle, K.C.B.
Colonel H. C. L. Holden, R.A., F.R.S.
Lord Curzon of Kedleston, G.C.S.I., G.C.I.E.
Sir William Thomas Lewis, Bart.
The Hon. Richard Clere Parsons, M.A.
Sir Westby B. Perceval, K.C.M.G.
Sir William Henry Preece, K.C.B., F.R.S.
Sir Boverton Redwood, D.Sc., F.R.S.E.
The Earl of Rosebery, K.G., K.T.
Carmichael Thomas.
Sir Aston Webb, C.B., R.A.
Sir William White, K.C.B., LL.D., D.Sc., F.R.S.
Sir John Wolfe-Barry, K.C.B., F.R.S.

ORDINARY MEMBERS OF COUNCIL.

Thomas Jewell Bennett, C.I.E.
Henry Taylor Bovey, M.A., LL.D., F.R.S.
William Charles Knight Clowes, M.A.
William Henry Davison, M.A.
Lewis Foreman Day.
Sir Robert Abbott Hadfield.
Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc.
Sir John Cameron Lamb, C.B., C.M.G.
Sir William Lee-Warner, K.C.S.I.
Colonel Sir Colin Campbell Scott Moncrieff, K.C.S.I., K.C.M.G.
Colonel Sir Richard Carnac Temple, Bt., C.I.E.
Sir William Hood Treacher, K.C.M.G.

TREASURERS.

Sir Owen Roberts, M.A., D.C.L., F.S.A.
Prof. John Millar Thomson, LL.D., F.R.S.

SECRETARY.

Sir Henry Trueman Wood, M.A.

On the motion of the CHAIRMAN, a vote of thanks to the Scrutineers was carried unanimously.

Sir BOVERTON REDWOOD, D.Sc., F.R.S.E., proposed a hearty vote of thanks to Sir William White for the able way in which he had conducted the affairs of the Society, as Chairman of the Council during the past year. So long as the Royal Society of Arts was able to secure for its Chairmen of Council such men as Sir William, the Society would still continue on its prosperous career.

The motion was seconded by Mr. ROBERT KAYE GRAY, who said he was sure he was only expressing the feelings of the other members of the Council in stating that Sir William White had proved an excellent Chairman, and that the meetings of the Council of the Society were a pattern for other societies.

The motion having been carried unanimously,

The CHAIRMAN acknowledged the vote of thanks.

The meeting then adjourned.

TRADE AND TRAFFIC BETWEEN CHINA AND INDIA.

A remarkably interesting account of Western China, more especially in respect of the opportunities it offers for the opening up of communications with Burma and India, is furnished in the recent Consular Report from Teng Yueh (or Momein as it is called by the Shan tribes) for the year 1908. The province of Yunnan, in the extreme south-west of which Teng Yueh is situated, is of vast extent, the northern districts being fed and tapped by the River Yangtze, and the eastern looking to the railway and waterways of the south to keep them in touch with French Indo-China and Canton, while the west is dependent on Burma for both its import and export markets. Although Teng Yueh has been a treaty port since 1902, there is no navigable river within

nine days' journey, and its trade is dependent on four mule roads, all leading up from Burma across difficult and mountainous country. Western Yunnan has been thus driven to become self-supporting to a large extent. Rice and vegetables are produced in abundance, with the result that there is a large and prosperous population with substantial and comfortable homes and lacking little but the cotton required for the blue clothing seen everywhere among Shans as well as Chinese. This for years past has been brought on mule back from Burma, and the construction of a good road has proved that the traffic finds favour with the people.

Among the products of the country are rice and opium, and of the former more is produced than is required for the food of the people; were it not for the prohibition of the export of rice there would be a good export. Similarly, opium was forbidden to cross the frontier into Burma, but there was a steady demand for the product in Chinese markets. From July, 1908, however, there was a rigid prohibition of the cultivation of the poppy, followed by uprooting of the plants in most places. Where crops, yielding from 300 to 400 per cent. profit, were formerly raised, farmers are now anxiously inquiring what substitute can be grown, profitable enough to enable them to buy imports from abroad. On the whole, the natives are a peaceful and well-disposed class and well aware that improved means of transport and the removal of the prohibition against rice export would be probably the best solution of the difficulty. There are also evidences of mineral deposits, and orpiment is exported in considerable quantities; but, owing to the difficulty of transport, the heavier minerals have only been worked in small quantities required for local consumption. Iron cooking pans and agricultural implements find their way to a certain extent from Upper Burma, but the price is too prohibitive for the trade thereon to develop.

As for the trade during the year, the silver return was the best that has been reached, but on a gold basis it became an actual decrease, owing to low exchange, the total being £235,449 as compared with £281,484 in the preceding year.

There is a good sale for such light and strong articles as can stand the overland journey, viz., towels, enamelled ware, cotton, thread, ribbons, umbrellas, metal buckets, tinned milk, cube sugar, carpenter tools, needles, and matches. Quite poor towns in China, if only possessed of good communications, are ready consumers of glass and kerosene oil, but the former is unknown in Teng Yueh.

Among the exports, raw yellow silk, hides, and musk figured prominently, the last item being evidently one of some commercial importance, for a traveller for a French perfumery firm is now engaged on his third musk-collecting expedition. Ponies and cattle of a sturdy breed are raised on these mountain pastures, and these should presumably find a ready market in Burma. Judging from the climatic conditions—which include a rainfall of about 60 inches, most of this falling in nine months of the year, and a long-day winter with warm bright days and a light frost at night, the thermometer ranging from 29° to 89° F.—the writer of the Report under review anticipates that apples, pears, apricots, plums, cherries would flourish, and given better communications, would prove a valuable addition to the exports. It is calculated that of the total trade entering Teng Yueh, about 70 per cent. proceeded inland, three-fourths of this quantity being probably consumed in Tali-fu and Yunnan-fu, one-fifth being transported across the upper Yang-tze and Sz-chuen, and the remainder finding its way into Kwei-chow. The fact of this trade making its way over mountain tracks for journeys of over two months shows that physical obstructions are no real hindrance to goods in popular demand. With the hope of establishing a good market for cigarettes, the British-American Tobacco Company have sent two travellers with gramophones and samples of cigarettes for free distribution among the Chinese, who seem quite willing to become regular customers for the goods, which clearly give satisfaction.

The Tonkin-Yunnan Railway was expected to reach Meng-tse this spring, and will be rapidly pushed forward to Yunnan-fu, the provincial capital, the completion of the line being promised early in 1910. The French rail-head will thus be brought within 220 miles of Tali-fu, the great distributing mart of Western China, while the British rail-head at Bhamo will be 280 miles from the same goal, the 60 miles difference meaning four days' heavy marching for a caravan on the Yunnanese roads. And during the malarial months the Burma route is most prejudicial to the mule drivers, which is a further handicapping of the British route, and shows the urgent need of carrying out the long-desired railway communication between Bhamo and Tali-fu. The same point, it may be remarked, is dwelt on in the Burma Administration Report (which has just reached the India Office), where it is pointed out that an important trade is greatly hampered by the want of easy communication in this direction.

A NEW FIRE EXTINGUISHER.

All who are interested in the question of fire extinction are familiar with the dangers and difficulty inherent to combating conflagrations where petroleum, gasoline, benzine, or other liquids lighter than water, are involved. As is well known, the attempt to extinguish with streams of water in such cases results usually in a spreading of the inflammable liquid, an increase of the area of combustion, and a greater intensity of conflagration. The use of steam or of a current of inert gas is available only for incipient conflagrations in well-closed rooms. It presupposes, also, the permanent location, on the spot, of stationary apparatus for the purpose. Accord-

ing to the American Consul at Chemnitz, a distinct step forward in the means of battling with such conditions has been made in Germany, where the use of a tenacious foam, dissipated with difficulty, has been found of great value in cutting off the supply of air necessary to maintain combustion, and thus extinguishing flame. The method and the requisite apparatus have been perfected at Salzkotten, near Minden, in Prussia, and have been submitted to exhaustive tests by the heads of the fire brigade and others interested in the question of protection against the dangers from combustible liquids. The apparatus employed consists of a simple metal cylinder, provided with a long spout, and divided into two chambers. One chamber is charged with an aqueous solution of potash alum and sodium sulphate, the other with a similar solution of sodium bicarbonate, sodium sulphate, and licorice extract. The cylinder is so arranged that, on being inclined or reversed, the two solutions mingle as they issue from the spout. There is no pressure evolved, and consequently the liquid does not issue with sufficient force to cause a spattering of the burning hydrocarbon upon which it may be poured. The result of the chemical reaction between the alum and the bicarbonate, is a prompt evolution of carbon dioxide which, in contact with the licorice solution, forms na exceedingly stiff and persistent foam. Such a layer of foam, containing an inert gas upon the surface of a burning liquid, cuts off all access of air, and combustion necessarily ceases. The temperature of the liquid may have reached a sufficiently high point, so that through evaporation, bubbles of the vaporised hydrocarbon rise, for a time, through the stratum of foam, and tongues of flame flutter over its surface. These soon cease, for simultaneously with the evolution of the carbon dioxide, there is a loss of latent heat, the temperature of the foam-yielding solution falls, and this, in turn, cools down the combustible liquid. The solution acts thus, in a double manner, as a protective agent. Among the numerous tests to which the apparatus has been submitted by the heads of fire departments in Germany, the following, by the head of the Hanover department, may be mentioned. An iron vessel, five and a-half by two and a-half feet in size, and four inches deep, received a charge of eighteen gallons of benzine. Benzine was likewise poured on the ground where the vessel rested. The liquid in the vessel, and outside the same, was lighted, and allowed to burn for three minutes. The contents of two foam extinguishers were then allowed to flow over the whole. Combustion was promptly arrested. The superincumbent layer of foam was then removed, and the benzine lighted anew. The attempt was now made to extinguish the flames by means of water, first with a simple, portable house extinguisher, and then, with the use of the city water supply, issuing from a two-inch hose. In neither case could the fire be extinguished. On the contrary, the area of combustion was rapidly extended, until it covered over forty square yards. It was then necessary to discontinue the use of the hose, on account of the danger to the buildings surrounding the court in which the experiment was conducted. The success attendant upon this and similar tests has led to the conviction among German authorities on protection against fire, that the foam extinguisher is capable of rendering valuable service in all places where combustible liquids are stored, and especially in automobile garages, and motor yachts. The use of liquid fuel for rapid locomotion by land, water, and air is extending so rapidly, that the new protective, it is said, will meet a distinct need.

FOREIGN SHIPOWNERS AND INSURANCE FUNDS.

It is often urged by British shipowners that they labour under great disadvantages as compared with their foreign competitors in that their obligations to their crews are greater. A return just issued at the instance of Lord Muskerry does not altogether support this contention. Indeed, it shows that in some important respects, and in some countries, more is done for the foreign sailor than hitherto has been done for the British. Take, for example, old-age pensions, and widows' and orphans' pensions. In Austria-Hungary members of the mercantile marine have no legal claim to pension, but there is a charitable fund, under official control, for the relief of old and disabled officers and seamen, and their widows and orphans. In Belgium, owners of merchant vessels are under obligation to pay to the Seamen's Benevolent Fund (Caisse de Secours et de Prévoyance), a sum amounting to 1½ per cent. of the total expended on the wages of all the seamen they employ. All officers, mechanics, sailors, stokers, stewards, cooks, and apprentices sailing under the Belgian flag, and enrolled on the ship's books, with the exception of seamen in Government service, and policemen, have to subscribe to the fund a sum amounting to 3 or 4 per cent. of their wages, according to their rank. Out of this fund pensions amounting to £9 in the case of cabin boys, and running up to £30 in the case of captains, are granted (*a*) in the case of inability to work on acconnt of old age, or on account of an accident met with while in the exercise of their calling; (*b*) in the case of infirmities incurred in the exercise of their calling. Widows of seamen who are members of the benevolent institution receive, under certain specified conditions, a pension varying from £9 to £24, and an addition of £1 16s. 8d. to £3 for every child under 18 years of age. In order that the widow may receive a pension her husband must have contributed to the benevolent fund for 20 years, and have been at sea for 15; their married life must also have lasted for a year. An orphan's pension is the same as that of a widow without children. Should there be more than one orphan in a family a further sum of £1 16s. 8d. to £3 is granted for every additional child.

Danish shipowners have no obligations towards their captains, officers, and crew as regards such pensions, but in France pensions are paid to all seamen on the register who have done 25 years' service in the navy or mercantile marine, and have reached the age of 50, unless previously incapacitated from work by illness. The pension for widows of seamen is fixed at half the maximum pension granted to the husband. After the death of the mother, or if she forfeit in any way the right to the pension, the child or children of the deceased pensioner receive, whatever may be their number, an annual sum equal to the pension that the mother would or might have drawn. The sum of 3 per cent. on the wages of seamen engaged by the month or voyage is paid into the "Caisse des Invalides," and the same percentage is also paid on the wages of seamen employed in the whale and cod fisheries. Owners and managers of all kinds of vessels and trades pay a tax of 3½ per cent. on all wages inserted in the ship's articles. The present subscription from seafaring men, whether on the register or not, engaged in ocean navigation, the international coasting trade, and deep sea fisheries is 1 per cent. on the salaries of officers, and ¾ per cent. on the wages of seamen. And there is a national fund for the benefit of sailors against the risks and accidents incidental to their profession.

In Germany the owner of a merchantman is not, as a rule, personally liable for compensation to seamen in case of accident. This burden is met by compulsory insurance, based on the principle of mutuality. The law as to it rests on three main principles: (1) that all persons employed at sea must be compensated for accidents occurring in the course of their carrying on their work; (2) that the necessary funds for this compensation must be provided by the shipowners alone; and (3) that this compensation must be provided by the shipowners to the extent of their trade. As with accident insurance, so is the provision to be made for old age taken out of the hands of the single employer, for the single case, and is regulated by general public legal rules, and here the liabilities of the shipowner are the same as those of every other employer. The "Invaliden Versicherungsgesetz" of 1899 includes, in the same degree, the ships' crews of all German merchantmen, without distinction as to their size or purpose. It embraces also foreign seamen, though they can, by a decision of the Federal Council, be excluded from the insurance. But in that case the employer is bound to provide the share which would otherwise fall to them. Widows and orphans of seamen enjoy certain advantages from the accident insurance funds, but further than this there does not exist in Germany at the present time any liability on the part of shipowners to provide for the widows and orphans of seamen employed by them. A Bill has, however, been introduced to provide for them, and is likely to become law.

In Italy shipowners are responsible for the deductions from the wages of their crews which are due to the "Fund for the Incapacitated of the Mercantile Marine," whose objects are: (1) to provide pensions and assistance to incapacitated seamen inscribed in the registers of seafaring men who have contributed to the fund; (2) to give assistance to seamen navigating under the national flag who may be destitute, or suffering from serious and unforeseen misfortunes. The contributions from seamen's wages to this fund vary from 4s. per month for a master mariner of a foreign going vessel to 8d. for a cabin boy. Assistance is given to widows without, or according to number of, children by the Fund. In the Netherlands, no provision is made for old-age pensions, or pensions to widows, and the same remark applies to Norway, Russia, Spain, and Japan. In Sweden, the Royal Regulations for Seamen's Homes provide for pensions to be paid by the seamen's homes to sailors either injured or in permanent ill-health, or too old to work, in proportion to their circumstances, and the same Regulations which provided for the husband or father, provide for the support of widows and orphans by the Seamen's Homes. There is also accident compensation.

THE SOCIETY OF ARTS AND AFFORESTATION.

One of the first objects to which the Society of Arts devoted its attention, was the encouragement of tree-planting, and as this fact is constantly referred to in discussions about afforestation, it may be interesting to give a few figures as to what was actually done. In 1758—four years after its establishment—the Society, in view of the fact that "a continual supply of useful timber is absolutely necessary, as well for the ornament and conveniency, as for the security of these kingdoms," offered a number of premiums, generally in the form of gold or silver medals, for the planting of various kinds of trees. These premiums were continued from year to year till 1835, and in this period no fewer than 115 gold and 34 silver medals, in addition to a few pecuniary premiums, amounting to some £200, were awarded. It is impossible to state with exactitude the number of trees planted which these awards represent, for although, in some cases, the particulars are given in the records of the Society with extraordinary precision, in others, such phrases as "extensive plantations" are used; but at the very lowest estimate this number must have considerably exceeded 50 million, of which some 20 million were firs and larches, and some 15 million oaks.

DEW-PONDS.

In Mr. George Hubbard's paper on "Dew-ponds," read before the Society on March 3rd (see *Journal* of March 5th, 1909, p. 335), it is stated "that at Gibraltar a large portion of the rock has been covered with corrugated iron on a wooden backing. On this surface the warm moisture-laden wind becomes chilled,

and the dew is deposited, and if I am rightly informed Gibraltar has now a supply of pure water."

Full details of the water system of Gibraltar may be found in the "Gibraltar Directory," pp. 7 and 8 of the section "Historical Notes," from which it appears that the supply of water for dietetic purposes depends entirely upon the rain-water collected on specially prepared areas, supplemented when necessary by distilled sea-water.

"In the year 1903," says the *Directory*, "an additional area was prepared as a collecting ground for rain-water on the sand slope over Catalan Bay, on the east side of the Rock. Ten acres of the sand were covered by galvanised corrugated iron sheets, with a channel at the bottom, from which a tunnel 700 yards in length was constructed; through the tunnel the water flows by gravitation in four reservoirs."

This work of laying down the "galvanised corrugated iron sheets on creosoted fir framing," was designed and executed by Mr. Wallace Copland, Engineer to the Gibraltar Sanitary Commissioners, and appears to have been carried out not for any purpose in connection with the formation of "dew-ponds," but merely as a means of collecting the rain.

ARTS AND CRAFTS.

New Lustre Pottery.—There have been so many new developments in artistic pottery, both at home and abroad in recent years, and so large a number of these have been connected with chemical experiments in various glazes, that one hardly looked for anything fresh, especially in the direction of flambé and lustre. Ever since the last Paris Exhibition (and for some little time before it) experiments have been made all over Europe in the direction of crystalline glazes, and within comparatively recent years at home we have seen both the wonderful re-discovery, as it might almost be called, of painted lustre first attempted by Mr. de Morgan, and brought to such perfection by Mr. Burton, of the Pilkington Tile and Pottery Company, and also Mr. Bernard Moore's admirable flambé. During the last few weeks, however, Mr. Goddard, of Messrs. Ashworth and Co., has been showing in London some results of his experiments in Staffordshire lustre. Mr. Goddard, so far at any rate, has not attempted anything in the way of painted lustre, but has contented himself with obtaining lustrous effects in his glazes—and many of his results make not only gorgeous lustre but beautiful colour—two things which do not always go together. It is apparently copper lustre with which Mr. Goddard works exclusively; at any rate none of the pots shown suggested at first sight silver lustre. Perhaps one of his most striking productions is the practically black glaze which in the light glitters with all the colours of a very brilliant rainbow. This he has often displayed on eight-sided bowls, where the various angles at which the sections are seen makes them all take different colours. He showed also a number of small vases in rather neutral coloured glazes, very unusual in lustred ware, and some of them were extremely delicate in effect. Amongst the most interesting pieces, however, are those in which the copper oxide has developed, as it were accidentally, into both turquoise blue and a deep ruby red, the contrast subtly harmonised by the sheen of lustre over it all. But, perhaps, the most delicate combination of colours occurred in a vase quite like a peach in effect, a peach which has ripened on one side only. It varies from a deep blush pink on the one hand to a pale greenish yellow on the other. Some of the delicate colourings where pale tints are flecked with little spots of pink are also very successful. The more startling colour schemes, where a vase varies from orange to deep melon green, or to a fine dark blue, have not the sublety of the more delicate effects, and would, perhaps, pall upon one after a time, though they are quite interesting to see.

Mr. Goddard has succeeded not only in producing lustre ware, but in getting a number of new and beautiful combinations of colour. There is, of course always an element of chance in this kind of thing (the fire may treat one piece kindly and practically spoil another) but the pots he exhibited went to show that he had a very adequate control over his material—that he had not only worked with a wide range of colours but knew pretty well how his ware was coming out of the kiln.

Arts and Crafts at Shepherd's Bush.—Huge exhibitions, though they very often contain a good deal of interesting work, are not generally easy places in which to find objects of decorative interest; and this year's show at the White City is no exception to the rule. From the plan, one would suppose that nothing would be easier than to inspect the Palace of Decorative Art and the Palace of Applied Arts and Crafts and to find at once all that was to be seen in the way of art and workmanship; but this is not by any means the case. The Palace of Decorative Arts, apart from a show of statuary, a large and good collection of photographs, and a few pictures, contains, it is true, a quantity of furniture exhibited by firms of repute, but this is almost all of it old, or on old lines—practically a retrospective exhibition rather than a show of the current workmanship of to-day—while the Palace of Applied Arts and Crafts (the stands are not yet all completed, and it is, therefore, perhaps, hardly fair to judge of its contents) seems to be mainly given over to manufactured jewellery. Indeed by far the biggest collection of craft work is to be found in the Women's Palace—though even here one is sometimes puzzled to find the connection between the exhibits and the title of the building in which they are collected. The International portion of the exhibition is, as such things usually are, a sort of mixture of a British bazaar and a street in a continental town; but there is enough in it to throw some side lights on what is being done in a few places abroad. The Dutch metalwor

and pottery—more especially the Arnheim ware—remind us (if we need reminding after the exhibition last year) that in Holland the *Art Nouveau* which we think of here already as ancient history, is by no means dead; whilst the Florentine leatherwork shows how the practice of lacquering leather has regained ground in the last few years—and how much more satisfactory is the colour of the Italian work than that of the corresponding English production.

The most important pieces of decorative work shown in the Palace of Decorative Arts, apart from the sculpture, much of which is, of course, in a sense decorative, are the two enamelled plaques and the large peacock candelabrum carried out in copper and enamel, exhibited by Mr. Alexander Fisher. Of the carpets, the beautiful examples shown by Messrs. Cardinal and Harford are, of course, all Oriental and the finest specimens are old. Messrs. Treloar's exhibit is interesting as including not only a number of Eastern carpets obviously made to European order, but also some very fine Axminsters. It is interesting, too, to see almost side by side, a remarkably satisfactory Axminster rendering of a beautiful sixteenth century Persian carpet from South Kensington and a rug bearing the Royal Arms made in the East. One smallish room is devoted to furnishing silks. They are mostly after old patterns, but those few that are modern are very much up-to-date. Some of the purples and mauves and kindred shades are very fine.

One is rather at a loss to understand why Mr. Howson Taylor's pottery should be shown in the Women's Palace except that it was there last year;—and there it is again—together with a few other exhibits which do not seem to have any special relation to women's work. Amongst the general exhibits most worthy of notice are the bookbindings of Miss Gedye and the jewellery of Miss F. Rimmington. This last, though on lines not altogether different from what other people are doing, is sufficiently unlike other work to be distinctively the artist's own—and is, moreover, good both in design and workmanship. It is only natural, however, that the greater part of the arts and crafts exhibits in the women's section should be connected with needlework, and there is quite a varied show of lace, embroidery, and such like; but it is, for the most part, rather the output of village industries than the production of very technically skilled workwomen.

From Narbett, Pembrokeshire, comes a case of quilted dressing-gowns, dressing-jackets, bedspreads, and other objects which reveal the fact that quilting is after all a British industry, and that those who admire the quilts to be seen in Sicily and elsewhere abroad, could with a little trouble get quilted things in this country quite as interesting in their way. English quilting in the old days was mainly, it is true, white stitched with white, and though the show at Shepherd's Bush is for the most part in colours, the stitching is of the same tint as the ground; but there is no reason why use should not be made of contrast in colour between the ground and the stitched pattern upon it.

There is lace from Ireland and elsewhere, but the most interesting show of this kind is that from Kingston Bagpuize and Longworth (Berkshire), where old Italian and other designs are reproduced by the villagers in gold, silver, or aluminium as the case may be. Some of the patterns are very satisfactory, and care is taken to get and to utilise different shades of gold and silver. Embroidery and drawn thread work are shown from places as distant as Hungary and India as well as from those much nearer home. There is a smallish frame of work from Dunleckney, County Carlow, Ireland, which includes a few pieces which, both in colouring and design, are at first sight, curiously Oriental. On closer inspection they remind one to some extent of a certain kind of work done in Brittany—itself reminiscent of Oriental needlework.

Although there is not as much modern craft work to be seen at the White City as the descriptions of the "Palaces" might lead one to expect, there is nevertheless scattered over the exhibition a sufficient quantity of such work to prove interesting to those who care for such things—only they must not mind the trouble of looking for them amongst a varied collection of other objects.

NOTES ON BOOKS.

PRIVATE HOUSE ELECTRIC LIGHTING. By Frederic H. Taylor. Third Edition. London: Marshall and Co.

This little manual will be found to give just the amount of information required by anybody using the electric light or contemplating its installation. Systems of wiring are described; the ordinary appliances, switches, lamps, fuses, and fittings generally are all figured and described; the cost of an installation and its working is discussed, and there is a fina chapter upon generators.

SPECIAL HOSPITALS. By Richard Kershaw. London: George Pulman and Sons, Ltd.

To those who claim specialism as the monopoly of modern times the historical chapter which opens this little work should prove enlightening. "Specialism in medicine," says Mr. Kershaw, "was nowhere more developed than in the ancient universities of Egypt, of Greece, and of Rome. In Egypt the sacerdotal doctors divided the human body into 36 anatomical parts, each part being dedicated to its own special deity;" and he quotes Herodotus to show that "every corner is full of physicians, some for the eyes, others for the head, many for the teeth, and not a few for the stomach and belly." According to Georg Ebers, "whoever required a physician sent for him, not to his own house, but to a temple.

There a statement was required of the complaint from which the sick person was suffering, and it was left to the principal of the medical staff of the sanctuary to select that master of the healing art whose special knowledge appeared to him to be suited for the treatment of the case." It is possible, of course, that the medical and surgical methods of ancient Egypt might appear somewhat crude to the modern practitioner, but the gold filling which has been found in the teeth of mummies shows that in dentistry, at least, no little progress had been made even in the time of the Pharaohs.

A great many centuries had to pass before this country could vie with the ancient world in the matter of medical specialism. In the sixteenth century so little progress had been made here in medicine that "it was held in both St. Andrews and Glasgow Universities to be a section of the theological faculty, until at the University of Aberdeen the first professor of medicine, and the only teacher of medicine then in Britain, was appointed, and paid at the rate of 'ten merks yearly.'"

The nineteenth century, however, witnessed a sudden and great development of special hospitals in this country. In 1801 the London Fever Hospital was founded, and in 1804 the Royal Ophthalmic Hospital. In the following year the citizens of Glasgow built a Lock Hospital, while in 1806 an Eye Hospital was opened in Exeter. Thenceforward the growth of special hospitals continued in ever-increasing numbers, until at the close of the century the United Kingdom boasted some 170 institutions for all kinds of diseases. The illustrations which Mr. Kershaw has chosen for his book are not without interest. One of the first represents the temple at Epidaurus, where a patient is sacrificing while his injured leg is being licked by the sacred servant. The last is a photograph of the operating theatre of the London Throat and Ear Hospital, fitted with all the appliances of the most modern science.

GENERAL NOTES.

BRUSSELS EXHIBITION.—The Royal Commission for the Brussels Exhibition have issued a memorandum containing information for exhibitors, from which it appears that the space to be occupied by the British Section is a little over 200,000 square feet. There will be a charge for space, varying from 2s. 6d. to 6s. per square foot. The higher charge includes cost of show-cases, the handling of goods in transit from the railway to the exhibition space, storage of empty cases, and re-loading at the close of the exhibition. The installation of machinery is not included. The Commission will pay half the charges for motive power supplied to machinery to illustrate processes of manufacture. A uniform scheme of decoration will be adopted, and various additional facilities will be provided for exhibitors and their agents. The Belgian State Railways charge full rates on the outward journey, but undertake to return exhibits free. The British railway companies make a reduction of 50 per cent. on returned exhibits—presumably the full charges will have to be paid for the outward journey.

TOWN PLANNING AND HOUSING EXHIBITION.—A Town Planning and Housing Exhibition will be held at Hampstead Garden Suburb, from July 14th to August 7th. A number of cottages and houses in the Garden Suburb will be open for inspection, and a large collection of plans, models, &c., will be on view in the Institute During the Exhibition, lectures and conferences will be held. Admission will be free on presentation of visiting card.

BEE DISEASE.—The Board of Agriculture and Fisheries desire to warn all bee-keepers that an outbreak of disease, believed to be identical with the Isle of Wight bee disease, has occurred in several hives in Buckinghamshire. This disease, which has destroyed almost all the bees in the island from which it takes its name, is due to a bacillus closely resembling the bacillus of Plague, and no remedy for it is known. It is of the utmost importance, therefore, that bee-keepers should take every precaution to prevent the disease spreading, and they are strongly advised to keep a careful watch for any signs of its appearance. A full description of the disease was published in the *Journal of the Board of Agriculture* for February, 1909, and bee-keepers who find symptoms of disease corresponding to the description there given should communicate with the Board of Agriculture and Fisheries, 4, Whitehall-place, London, S.W.

EMPLOYMENT OF CHILDREN.—Attached to the annual report of the Chief Inspector of Factories and Workshops is a report by Miss Squire, one of the lady inspectors, on the employment of children and young persons. An enquiry was made by Miss Squire into the main features of the employment of children in carding of hooks, eyes, and buttons in Birmingham. The investigation showed that children of from 7 to 13 years of age are employed to a very considerable extent, often at late hours by artificial and insufficient light, straining to the eyes, in this monotonous and tiring work in their own homes; that the work is largely dependent on child labour, and is miserably paid, being a last resource of poverty where there are children to help. The employment cannot at present be regulated as it is excluded from the scope of the Factory Act by Section 114, and from the Children's Employment Act, the parent being the employer. Sometimes the work was found to be supplementary to Poor-law relief. Further inquiry seems to be needed.

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All communications for the Society should be addressed to the Secretary, John street, Adelphi, W.C.

NOTICES.

THE ALBERT MEDAL OF THE SOCIETY.

The Council of the Royal Society of Arts attended at Marlborough House on Wednesday, the 7th inst., when His Royal Highness the Prince of Wales, President of the Society, presented its Albert Medal to Sir Andrew Noble, Bart., K.C.B., D.Sc., D.C.L., F.R.S., "in recognition of his long-continued and valuable researches into the nature and action of explosives, which have resulted in the great development and improvement of modern ordnance."

The members of the Council present were:—Sir William H. White, K.C.B., LL.D., D.Sc., F.R.S. (Chairman), Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., Thomas Jewell Bennett, C.I.E., Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D., Lord Blyth, Sir William Bousfield, M.A., LL.D., Henry Taylor Bovey, M.A., LL.D., F.R.S., William Henry Davison, M.A., The Hon. Sir Charles W. Fremantle, K.C.B., Sir John Cameron Lamb, C.B., C.M.G., Sir William Lee-Warner, K.C.S.I., Sir Westby Perceval, K.C.M.G., Sir William Henry Preece, K.C.B., F.R.S., Carmichael Thomas, Prof. John Millar Thomson, LL.D., F.R.S., Sir William Hood Treacher, K.C.M.G., and Sir John Wolfe-Barry, K.C.B., F.R.S.

PRACTICAL EXAMINATIONS IN MUSIC.

The practical examinations in Music were not concluded this year until the 3rd July, too late for the results to be included in the Report of the Council. They lasted for 10 days.

The examinations were conducted by Dr. Ernest Walker, M.A., and Mr. Burnham Horner.

The system of examination was the same as that for recent years. For instrumental music certain standards are given, and candidates are asked to select for themselves which of these standards they choose to be examined in. The standards range from easy to very difficult music. For each standard a list of music is given for study, and from this list candidates select the pieces they will sing or play. Candidates are expected to play or sing the pieces which they have prepared, to play or sing a piece, or portion of a piece, at sight, and to play certain scales.

In all, 400 candidates entered, and of these 392 were examined, a decrease of 40 as compared with last year. There were 298 passes and 94 failures.

The following were the subjects taken up:—Piano, singing, violin, violoncello, clarinet, and flute. 323 entered for the piano, 247 of whom passed; 51 entered for the violin, of whom 36 passed; 3 entered and passed for the violoncello; 13 entered for singing, of whom 10 passed; 1 entered and passed for the clarinet, and 1 for the flute. One medal was awarded.

The Examiners mention the following points, as some to which candidates and their teachers might, with advantage, pay special attention. The sight-reading, especially of the singers and pianists, was, on the whole, inferior; the tone-quality of the pianists (more especially in the junior grades, but to some extent in all) was often susceptible of decided improvement, and more thought might well be applied to the inculcation of the technical methods necessary to secure tone-quality; among the pianists, pedalling was often a weak feature, and among the violinists the bowing was often stiff. In many cases, candidates entered for a standard for which their attainments were, as yet, hardly sufficient; but, on the other hand, a considerable number gave evidence of talent and good training.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE PUBLIC SUPPLY OF ELECTRIC POWER.*

By G. L. Addenbrooke, M.I.E.E.

PART I.

Connection with Lighting.

When about twelve years ago the question of the distribution of electric power first seriously arose in this country, it was thought that it would be necessary to separate it from the supply of electric light, except where the power users were small, on account of the difference in pressure caused by throwing large motors on and off the supply mains. These differences were important at the time, and in the egislation relating to power supply, supplies for power and lighting were largely differentiated. Since then, however, improvements in prime movers, particularly the adoption of the steam turbine, distribution at higher pressures, and the better design of motors and of appliances for starting them, have brought it about that in properly designed systems of sufficient size the pressure in the mains can be kept within such limits that good lighting is practicable from the same mains which supply power.

An electric power station of modern type is, therefore, capable of supplying electric energy for all purposes, including heating, and to avoid unnecessary capital expenditure and duplication of supplies it is advantageous that the different classes of services should be supplied from the same source.

I mention this at the outset because electric lighting legislation in the United Kingdom has been a barrier to electric supply on a wider basis, and still remains so, and because my subject is already too extensive to permit me to refer to lighting supply at any length.

Preliminary.

I wish also to commence by asking the indulgence of my hearers for the method of treatment which I have adopted on the subject of these lectures.

To be successful the supply of electric power or energy must rest on an economic basis; there are other points which tell considerably in its favour and which are not capable of being expressed in figures, but speaking generally cost is a governing factor.

It is impossible, therefore, to avoid making this a considerable feature in any comprehensive presentation of the subject, and the importance of the technical points which arise is approximately measured by the way they bear on it. Although, therefore, the technical side is to myself and probably to my audience, the more interesting, I have felt compelled to discuss the economic sides of the question at considerable length. The bearing of the technical points will then, I think, be better understood and the possibilities of development be more correctly estimated.

Uses of Electrical Power.

As the adoption of the electric motor for driving machinery is now becoming so universal not only in manufactories, but in the mining and other industries, and electric power supply is making progress for railway working besides in its application to tramways, lighting, and heating, it will be worth spending a little time to commence with, in trying to form some conception of the extent to which power is at present used in this country, and the proportion of it which has already been electrified.

Coal Commission Report.

There are, unfortunately, no direct statistics of this as yet, though I hope such will be obtainable when the report of the industrial census which is now being taken is forthcoming. Some estimates were, however, made at the time when the late Coal Supply Commission were sitting, and these, coupled with experience gained in connection with electric power supply, enable a few figures to be put forward which are at any rate of the right order though they may not be very accurate.

According to the Coal Supply Commission report, there were used in 1903 about

53,000,000	tons	of coal in	factories.
18,000,000	,,	,,	mines.
13,000,000	,,	,,	railways.
5,000,000	,,	,,	brick and chemical works.
28,000,000	,,	,,	iron and steel works.
15,000,000	,,	,,	gas works.
32,000,000	,,	,,	domestic purposes.

And probably these figures are not far from correct now.

* The Course consisted of three lectures, delivered on January 18 and 25, and February 1. In re-arranging the material for publication, the lecturer has preferred to divide it into four parts.

Horse-Power in United Kingdom.

Of course, a great deal of coal is used for heating, but, taking this into consideration, it would appear, from the above and other data, that the total horse-power installed in the United Kingdom in factories and mines is something under 9,000,000 horse-power, including gas-engines, and there is also about 1,300,000 horse-power installed in electric lighting, power, and tramway stations.

To estimate the amount of power used on railways is not easy owing to the difficulty of defining what is the horse-power of a locomotive; but it would appear that if the railways of the United Kingdom were all driven electrically with power supplied from large generating stations, the horse-power required would be well under 2,000,000. As an interesting side issue, it may be worth noting that there must also be much over 500,000 horse-power installed in motor-cars and motor omnibuses in this country at the present time, and that this total is certain to be greatly increased in the near future.

These figures must be taken as very approximate, but in the absence of more definite information they are useful in giving some idea of the magnitude of the problems involved. It is also interesting to have some data showing the amount of power by which the population of this country has supplemented its own efforts to reach our existing state of civilisation. It will be noted that this is in the neighbourhood of ¼ horse-power for each person for all purposes. The writer considers that this is rather an over than an under estimate, as he invariably finds that power users have a tendency to exaggerate the amount of power they use and to under estimate the amount of coal used per horse-power hour.

In the United States it has been usual for some time to take a power census every five years, and the figures of the last, viz., 1905, are quoted in the *Electrical Review* of October 11th, 1907. Without going into detail it may be said that the figures show a total of nearly 15,000,000 horse-power in use, including water-power, the figures for electric supply being for the same date about three times those for this country. The United States population is of course double that of Great Britain, but nevertheless these figures are worthy of the consideration of politicians, as it is evident that no unnecessary obstacles should be placed in the way of power supply, if this country is to maintain the place it now holds. It is also worthy of note that between 1900 and 1905 the horse-power installed in the United States is stated to have increased 40 per cent.

To return, however, to our subject. Out of the 8,000,000 to 9,000,000 horse-power employed in the mines and manufactures of this country, probably 70 per cent. is situated within populous districts, since over 78 per cent. of the population live in such districts, and manufactures, mining and population are always closely associated.

Power Capable of being Supplied from Public Supply.

Of course some of this power is not suitable for conversion to electric driving, and some has already been converted, but we shall probably not be far wrong in saying that there is at this moment in Great Britain over 4,000,000 horse-power of engines situated in towns and urban districts and their neighbourhoods, and within the central portions of the areas of the power supply companies who have been granted acts for this purpose, and which could be economically replaced by power supplied from properly grouped stations, the remainder being in large works and collieries or works situated in the more rural districts which can probably most advantageously produce their own electric supply.

That the possession of cheap power in a form which is easily sub-divided, and utilisable over large areas, would lead to extensions in its use, is also manifest, though it is impossible to define this in figures.

Economies to be Effected in Use of Coal.

To give an idea of the economies to be effected if the best modern practice were generally adopted for generating power, the Coal Commission estimated that if electric driving and the most modern plant were universally substituted in collieries for the plant at present in use, the coal consumption which now is more than 6 per cent. of the total coal raised would be reduced to one-third, and it is safe to say that if electric main winding which is now coming into use, were also adopted, and if the supply were furnished by grouped stations where practicable, even this economy would be exceeded, so that there would be a saving of coal in this

industry alone of some 12,000,000 tons, which at the low value of 5s. per ton, would effect a saving of £3,000,000 per annum.

The saving of coal by adopting electric driving and grouping the power supply as far as possible would not be so great in other industries as in mining, but it is a moderate estimate of what we know the savings to be by grouping or using the most efficient modern isolated plant to say that the coal consumption, taking all other industries, could on an average be reduced to half of what it is now, or by over 20,000,000 tons per annum, of an average value of nearly £10,000,000 if carriage and handling is included. The annual cost of this power at the average figure of £6 per horse-power, including interest and depreciation, is for all industrial purposes in excess of £50,000,000 per annum.

Industrial Districts of United Kingdom.

Most of the power used in the United Kingdom is located in fairly well defined areas, of which Lancashire and Yorkshire are the principal; then follow the North-East Coast, then the Midlands, next the Clyde Valley, and South Wales, and lastly the metropolitan area. There are besides these several other districts of less considerable dimensions.

There being this opening for electrification and for power supply, we have next to consider how the demand is being met. This is now being done in three ways:—

(1) Manufacturers and mine owners are installing their own plant.

(2) Supply is being given from the stations of electric power supply companies, which were established for this purpose.

(3) Supply is being given from the public supply stations established primarily for lighting towns, of which, outside London, the larger proportion is in the hands of the local authorities. There are in all now 451 of these undertakings throughout the country, of which 297 are in the hands of the local authorities and 154 are operated by companies.

As regards heading (1) there will always be a certain number of works and mines situated in isolated positions, which, if they desire electrification, as most of them will sooner or later, must in all probability depend for their supply of energy on generation within their own confines, or they may be able to form a little local group. On the other hand, there are works and mines operated on such a large scale and able to utilise such a large horse-power that they can erect and work their own generating stations to as great an advantage as if they took their supply from an outside source, though it is very remarkable how in a number of instances such works have agreed to take a supply of energy from an outside source where a suitable one has been available. With electric power users in these categories we shall only be incidentally concerned in these lectures, which will be devoted to consideration of the conditions which cover supply from a public source.

I have tried to get some figures which would indicate to what extent electric power has already been privately installed in works in this country, but owing to the multiplicity of manufacturers, and the amount of plant which has been imported from abroad, I have found it impossible to arrive at any data of serious value. Probably 1,000,000 horse-power is an under estimate.

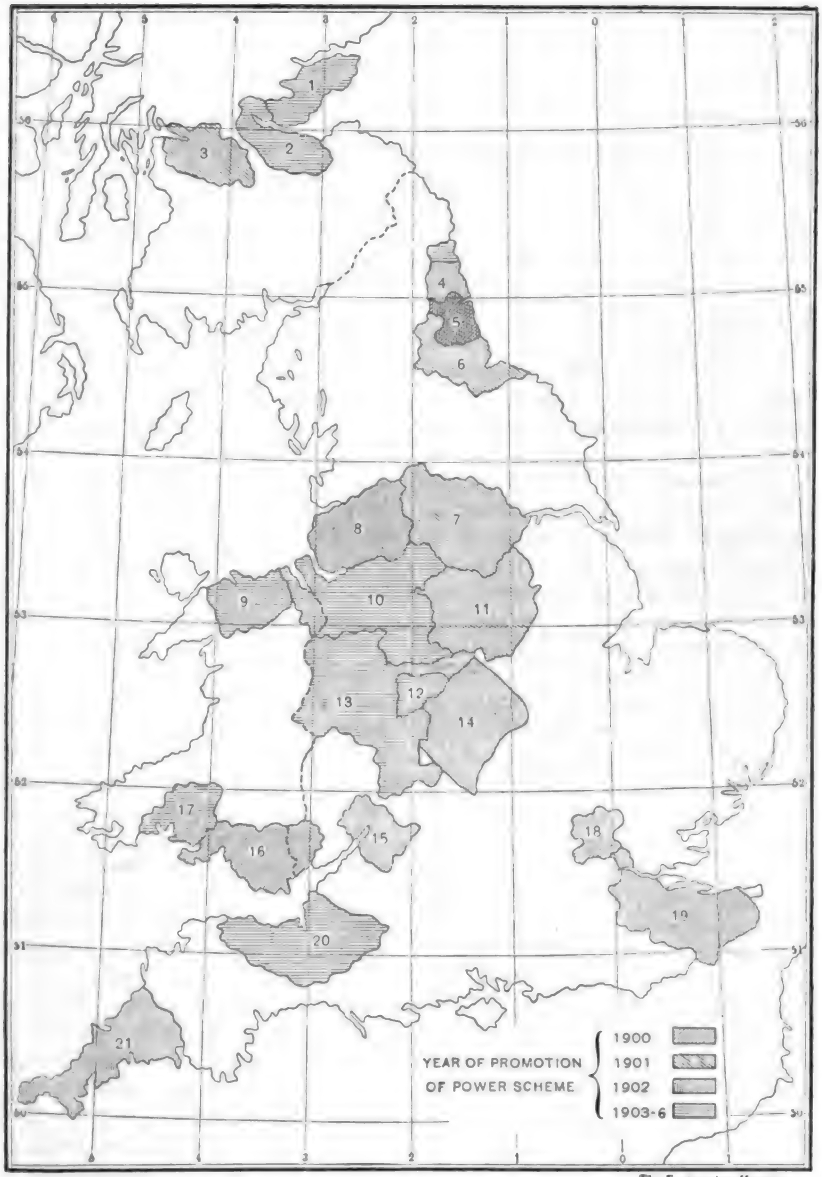
The Electric Power Acts.

It was in 1898, or just over ten years ago, that proposals for supplying power from public centres on a large scale first came to a head in this country. At that time, the question of municipalities supplying power in any way, except to small users who could be served off the lighting mains, had not seriously arisen.

It was thought improbable at the time that the local authorities would care to undertake this work, or that Parliament would sanction their going into a business which needed so much capital, and which was rather concerned with individuals than with the public at large. At the same time, owing to the wording of the Electric Lighting Acts, they had technically the right to do so where supplying lighting, as, when the Electric Lighting Acts was passed, supply for all purposes was included, since it was not then expected that the demand for power could ever be considerable.

Under these circumstances, and on the findings of the Joint Committee of the Two Houses of Parliament, in 1908, which emphasized the importance of making provision for electric power supply on a wider basis, there were passed between 1899 and 1905, about twenty-three Power Supply Acts, which cover all the industrial areas of the United Kingdom of any moment, and *prima facie* provide a solution of the question. The areas of these different companies are shown on the

SKETCH MAP SHOWING THE AREAS IN ENGLAND, SCOTLAND, AND WALES, OVER WHICH PARLIAMENTARY POWERS FOR ELECTRICITY-SUPPLY HAVE BEEN OBTAINED.



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The companies holding the powers designated by corresponding numbers on the map are as follows:—1. Fife; 2, Scottish Central; 3, Clyde Valley; 4, Newcastle Electric Supply–Newcastle and District Lighting; 5, County of Durham; 6, Cleveland and Durham; 7, Yorkshire; 8, Lancashire; 9, North Wales; 10, North Western; 11, Derbyshire and Nottinghamshire; 12, Midland; 13, Shropshire and Worcestershire; 14, Leicestershire and Warwickshire; 15, Gloucester; 16, South Wales; 17, Carmarthenshire; 18, North Metropolitan; 19, Kent; 20, Somerset; 21, Cornw

Powers have also been granted to an Irish company known as the Shannon.

accompanying map. In these Acts, however, nearly all the towns in the respective areas having electric lighting stations, secured the right to exclude the local power company except by agreement, and many districts obtained electric lighting powers purposely to put themselves in a position to bargain with the power company. Thus it came about that although holding powers over important areas, when the districts in which most of the power companies were free to operate were examined after obtaining their acts, and after taking into account the exceptions which were granted at the instance of local authorities, it was found that as a rule the portions of them which the power companies could enter freely and which were of value were considerably restricted, their rights over the remainder being also to a a large extent only permissive and depending on subsequent arrangements being negotiated.

The full seriousness of this was not appreciated immediately as it was thought that by negotiation arrangements could be made within a moderate time with the authorities having these protective clauses to permit power supply in their areas, and that thus a position similar to that originally contemplated might soon be built up. On the north-east coast this has been to a great extent possible owing to the fact that the lighting of Newcastle was in the hands of a company which at an early stage amalgamated with the local power company, and thus a large going undertaking was quickly established and a moral effect created which has had an important influence in enabling agreements to be made with other local authorities.

In no other district in the United Kingdom, however, has there been such a favourable combination of circumstances, although there are other districts where the prospects of power supply apart from this question are as favourable, though perhaps more difficult to develop at the outset.

Attitude of Local Authorities.

Not unnaturally, local authorities are conservative in conceding rights which they think may be of value, and in the case of new developments it must be remembered that the old motto, *omne ignotum pro magnifico*, contains an important truth. Unfortunately, the form of procedure prescribed by Parliament in connection with the Power Acts, which was modelled on railway and tramway legislation, and was formed to deal with definite projects, was in many respects unsuitable for the presentation of the scheme of an undertaking which, starting from a centre, must be built up by degrees. This, in my opinion, led to the Power Acts appearing to be of a more aggressive character than they really were, and gave to outsiders the impression that undertakings of this character could be started and developed more easily and rapidly than I think even their most sanguine promoters imagined. Local authorities were thus led to the view that they would do well to stand off and await developments when it seemed probable that if the companies succeeded better arrangements might be effected than by an early agreement, and thus the development of most areas has been a tedious operation, though progress towards a better understanding is now making more headway. Again, as in the commencement of all important and complicated new movements, many mistakes have been made, and there have been many misconceptions as to what could or could not be done.

For these, then, and other reasons into which I will not enter, progress in developing most of these companies has not altogether followed the lines which were originally proposed and which would have led them first to develop the more urban districts of their areas where the preponderance of the smaller classes of power consumers are situated and the work is also more concentrated, and then to extend to the heavier industries in the more open districts afterwards. The opposition given by many towns to railways in the early days of these enterprises will be familiar to many, an opposition which has not ceased to be a detriment to these towns ever since. As time goes on, I believe that it will be found that history has repeated itself in the case of electric power supply. Debarred in a great measure from developing their business in the natural way, the power companies have been compelled to approach the heavier industries in the more open parts of their areas somewhat prematurely, and at the same time the fact that they were not free to enter some of the best parts of their respective areas reduced their initial commercial outlook, and led to their being started on a smaller scale than had originally been contemplated, a fact which is of much importance in this class of work.

Most of the power companies have, therefore, progressed more slowly than was anticipated, though a great amount of groundwork has been done which will tell later on. They are now getting a hold on the portions of their areas which are open to them, and are increasing their loads to a point which gives them a better command over the business, and should lead to more rapid development in the near future.

It was the attitude of the local authorities towards these undertakings at the commencement of what may be called the power supply movement that led Mr. Dixon Davies to read his paper on the "Cost of Municipal Enterprise" before this Society on the 3rd of February, 1899, and also the further paper which he read before the Society on the 30th of January, 1903.

Power Supply by Local Authorities.

The action of the power companies having brought the subject of power supply prominently forward, municipalities possessing stations, who opposed the entrance of power companies, were forced to move in the matter to some extent themselves, and in most of the large towns considerable efforts have been made, especially within the last two or three years, to meet the demand for power. Unfortunately in the returns that are made to the Board of Trade by electrical undertakings supply for power is not separated from lighting supply, and thus there are no official data as to the extent to which power is at present being supplied by local authorities.

The following are, however, a few figures available. Recent evidence shows that the local authorities in London are supplying over 20,000 horse-power for motors, and it has been stated by the engineer of the Manchester Corporation that the horse-power of motors connected to the mains there is in excess of 25,000, while at Glasgow the total exceeds 23,000. At Birmingham the load is increasing very fast, but owing to later development probably does not exceed half the amounts mentioned, though it no doubt will approximate to them later. In Sheffield, Leeds, Bradford, and other industrial towns a good deal has also been done towards meeting the demand, and nearly every town in the kingdom having an electric lighting station has made some effort in this direction.

In 1899, when Mr. Dixon Davies first drew the attention of this Society to the matter, local authorities had invested about £6,000,000 of public money in electric supply almost wholly for lighting alone. When he read his second paper, in 1903, this had increased to £23,000,000, a small proportion of which was for power supply. At the present date the sum is about £42,000,000. Probably of this latter sum £8,000,000 to £9,000,000 is due to arrangements for power supply apart from tramway and lighting supply; on the other hand, if the output in units is adopted as a basis, it will be found that the output for power is in many cases fast approaching that for lighting, and in some cases exceeding it, although it must be remembered that, on an average, about three units are sold for power at the price of one for lighting, owing to the longer hours over which the power demand is spread and the cheaper price at which the supply can be given. Nevertheless, in their eagerness to hold and secure power supply it is clear that many local authorities are doing this to a considerable extent at the expense of the lighting customers, who are bearing a disproportionate amount of the overhead charges. To some extent, undoubtedly, power supply must follow lighting, since many of the smaller power users can only be reached profitably off the lighting mains; but the supply of large individual consumers, often needing the expenditure of several thousands of pounds in the stations and in the mains to reach them, is another matter; yet this is not infrequently now being undertaken by municipalities.

Note.—*Statistics of Power Supply.*—Since these lectures were delivered, the *Electrical Review* has, by private inquiry, obtained returns from each central station in the country of the horse-power of motors connected. The majority of the returns relate to December, 1908, or March 31st, 1909, and are therefore approximately six months later than the writer's estimates as given in the lectures. They do not seriously differ from the writer's figures, but he takes the opportunity, with due acknowledgment to the *Electrical Review*, of substituting these later and more authoritative figures. According to this return, the horse-power of motors installed by customers taking supply from the public mains of stations owned by local authorities was 309,346 horse-power. On the same basis, the motors connected to the mains of electric lighting companies throughout the country, including London, working under Provisional Orders, was 118,625 horse-power. The following Table, extracted from the *Electrical Review* returns, shows the position of the power companies to date; the figures given in the lectures have been slightly modified to make them accord with these latest results.

ELECTRIC POWER COMPANIES.

Name of Power Company.	Power station capacity.	Maximum load recorded.	Total connections of all kinds.
	Kilowatts.	Kilowatts.	Horse-power.
1. Cleveland and Durham County Electric Power Co.	6,500	7,550	25,600
2. Clyde Valley Electric Power Co.	8,000	4,700	18,250
3. Cornwall Electric Power Co.	..	..	..
4. County of Durham Electric Light Co.	..	..	27,500
5. Derbyshire and Nottinghamshire Electric Power Co.	1,500	624	..
6. Durham Collieries Electric Power Supply Co.	11,000	4,927	11,563
7. Fife Electric Power Co.	600	..	..
8. Gloucester Electric Power Co.	..	..	..
9. Kent Electric Power Co.	3,500	800	2,433
10. Lancashire Electric Power Co.	8,000	2,450	5,000
11. Leicestershire and Warwickshire Electric Power Co.	..	..	..
12. Midland Electric Corporation for Power Distribution, Ltd.	6,200	3,822	8,500
13. Newcastle-upon-Tyne Electric Supply Co., Ltd.	47,000	37,400	103,961
14. North Metropolitan Electric Power Supply Co. (Four Stations)	11,450	6,320	13,381
15. North Wales Power and Traction Co. Ltd.	4,000	..	3,050
16. North-Western Electricity and Power Gas Co.	..	..	..
17. Scottish Central Electric Power Co.	2,700	800	..
18. South Wales Electrical Power Distribution Co.	C. 1,900	1,425	..
	T. 7,500	3,040	..
19. Yorkshire Electric Power Co.	6,000	3,393	9,497
Totals	125,859	77,251	228,735

CAPITAL OF POWER COMPANIES AND HORSE-POWER SERVED.

Turning now to the power companies, notwithstanding the difficulties they have had to contend with, the capital embarked in them stands at about £7,500,000, and they have some 126,000 kilowatts of plant installed besides plant in process of installation. The horse-power connected to the mains of these companies is, according to recent information, 229,000, with considerable additions on order. Of this total it is worthy of note that the companies working together on the north-east coast and covering the Newcastle, Durham, and Cleveland districts account for nearly half the capital expended in the whole kingdom, and that they have 136,000 horse-power of plant in their stations or in course of erection, while they are at present supplying manufacturing and electro-chemical and lighting works to the amount of 156,000 horse-power. This shows the possibilities of development when the field is open and opportunity favourable. It has recently been stated by Mr. Merz, the engineer of these companies, that for the power employed in the numerous works on the north bank of the Tyne 95 per cent. is being taken from the power company. These figures do not include capital spent by electric lighting companies throughout the country in power supply, which, including the London companies, may, I estimate, be fairly put at £4,000,000 to £5,000,000, nor does the horse-power given include that served by them, which probably approaches 100,000.

TOTAL HORSE-POWER OF PUBLIC SUPPLY BY COMPANIES AND LOCAL AUTHORITIES.

Thus in one way or another, by the power companies and by the companies in London and the provinces which were formed for lighting, motors are now being supplied with power from public stations established by private enterprise to the amount of nearly 350,000 horse-power. If we add to this the power which is being supplied by municipalities and given above, say 309,246 horse-power, the total approaches 660,000, which is the total horse-power of electric motors in the United Kingdom installed on consumers' premises and supplied from central stations with electric energy, while the total capital embarked must be in the neighbourhood of £20,000,000, an appreciable proportion of which, however, is in anticipation of further requirements.

The industry of power supply has therefore become a large one already, and we have

seen the further scope there is for it irrespective of the increase in the use of power which will certainly follow its being supplied cheaply and on an extended scale. That the position at present in large areas is in many respects a chaotic one will also be clear from what has been said above, and it must be manifest that it is very important that the facts should be considered on an impartial basis; and that further development in each locality should be arranged for on the best lines.

NOTE.—*Power Supply in France.*—Since the lectures were delivered, through the courtesy of M. A. Alby, the writer has received an interesting printed pamphlet giving particulars of the power companies in France. These companies are operated on much the same lines as the power companies in England but are doing a larger proportion of lighting. A much larger amount of work is done by means of overhead conductors which in one case extend to a distance of more than 150 miles. In France the physical conditions are not altogether comparable with those in the United Kingdom, being more favourable in some respects and less so in others. On the one hand there is in France, especially in the south, on the Swiss border, and along the Pyrenees, much more water-power than there is available in this country; on the other hand in France, outside one or two localities, there is not the concentration of manufactories within the limited areas which offer scope for power supply on a large scale as in a number of districts such as we have in this country. Nevertheless the course of the industry in France has been smoother and more prosperous than in this country. The total capital invested in the 23 French companies above mentioned appears to be about £10,300,000, and for this expenditure there are power stations having some 320,000 horse-power installed, of which about 230,000 horse-power is water power, and about 90,000 horse-power is steam, a proportion of the latter being reserve plant in case of failure of the water supply. Of the companies the largest is the "Energie Electrique du Littoral Méditerranéen." This company has a share capital of about £1,250,000, and obligations or debentures for an equivalent amount, so that its total capital is about £2,500,000.

PROGRESS IN PRODUCTION OF POWER GENERALLY.

After this brief review of the present position of electric power supply in the United Kingdom, we will now pass on to consider electric power supply as an industry in itself. Since the power supply movement seriously began in this country, about 10 years ago, there have been considerable changes and developments both in the generation and supply of power on the small as well as the large scale, so that the position is in some respects different from what it was in the earlier days of the movement. For generating power on the spot where it will be used we have had the acceptance of the high-speed engine for driving works electrically, and also there has been the advent of producer gas and the increased use of gas engines and oil engines, particularly of late the Diesel oil engine. By economies due to the use of these engines and other ways, what may be called the standard of the cost of power in this country has probably been lowered some 25 per cent. altogether. By this is meant not that power is being produced more cheaply where the old plant remains, but that where changes are about to be or have been made, manufacturers are able to get estimates showing some such saving as this by reconstructing their own supplies. Therefore in taking a supply from an outside source they have naturally put the one against the other, and thus it has come about that there has been, speaking generally, what may be called a fall in the market value of power to something like the extent mentioned within the last few years. On the other hand great economies in the cost of plant of large size, in its efficiency, and in the cost of distribution have also been made, and on the whole it can be fairly said that the practicability, economy, and desirability of generation and distribution on a considerable scale have advanced as much as on a small one.

CURRENT PRICES FOR POWER SUPPLY.

We will now consider briefly the class of prices which it is found manufacturers and others are prepared to pay for power supply from an outside source, and which consequently must compare favourably with the prices at which they can produce it themselves.

In the industrial areas for the smallest class of power users, who are for the most part supplied from low pressure mains, prices of 1½d. to 1d. per unit (1⅓ horse-power hours) enable electric supply to compete with the gas or oil engine which would otherwise be installed, and often to replace it. As the sizes of engines increase prices fall rapidly, the price of supply to ordinary manufactories working the usual hours and taking from 200 to 400 horse-power being from ·85 to ·75 of a penny per unit or thereabouts; when we come to larger supplies of greater regu-

larity, there are often discounts on these figures; again, for such loads as cotton mills, where the supply is both large and regular and for fairly long hours, prices of about ½d. per unit are being quoted, while for collieries the prices will range between ·7d. and ·4d., depending on the amount of pumping, fans, and other continuous work which goes to make up the load. Where the load is spread over the 24 hours and of fair magnitude the price will be about ·4d. to ·5d. per unit. Again, for large power supplies for the 24 hours continuously throughout the year, such as are used in electro-chemical operations and where the supply is near the power station, lower prices again prevail. I am aware of one large contract which was made for less than ·2 of a penny per unit, but a more usual price where the quantities involved are not so large is a farthing to one-third of a penny per unit.

Where coal is more expensive than in the industrial districts situated on coal-fields, the prices will need to be one-tenth to one-eighth of a penny per unit more to make up for the difference in the price of coal. In the towns it is possible to secure rather better prices than in the more open industrial districts, say to the extent of one-tenth to one-eighth of a penny per unit, as space is more valuable, and it is usually necessary to burn a rather higher class of coal to avoid smoke. It need hardly be said that such prices as those mentioned for cotton mills and collieries cannot be remunerative unless the station is of very considerable size, not less than 10,000 kilowatts for instance, or unless the circumstances are very favourable. On the other hand, in many of the industrial districts there is ample scope for single stations of 30,000 to 40,000 kilowatts capacity if the area is laid out to the best advantage, and in the larger industrial districts several of these stations linked together would be needed really to deal with the supply on a proper basis. In this case such prices as have been mentioned could be reduced, while still leaving a fair profit to the power supply undertaking.

In practice these prices are found to work out at from £3 to £4 per horse-power of motors installed per annum, which agrees well with what was said above as to the reduction in the market value of power, since a figure which was formerly current was £5 per indicated horse-power per annum as the cost of steam-engines of fair size worked under good conditions.

Influence of Capital on Cost of Supply.

The cost of supplying power varies largely with the quantity supplied and the hours of daily use, since out of every pound a customer pays for power for use during ordinary working hours, nearly 10s. is needed to cover a fair interest on the capital employed, depreciation, and contingencies; and as these vary very little, whether the supply is taken for a shorter or longer time per diem, the charge for power is often in practice made up of a fixed charge per annum on the maximum power supplied, together with a small charge per unit used, say, ·15d. to ·33d. to cover actual working costs.

Charging for Power.

The question of how power should be charged for is a very vexed one. To do this with theoretic fairness a double sliding scale is necessary, first to cover the price for different length of employment per diem, and, secondly, to accord with the quantity used, which latter is often accomplished by a varying set of discounts. It is found, however, that manufacturers object to these complicated tariffs, and as the knowledge of the average amount of work done in different trades increases there is a disposition to make contracts at fixed prices with a right of variation if, at the end of different periods, the recording instruments show that the power taken differs seriously from the contract amount either in quantity or rate of use.

Measurement of Power Supply.

Power is always measured by meter, often by a 2-rate meter, or by an attachment now frequently fixed to the meter by which the number of revolutions of the revolving disc in a given time, say half-an-hour, is counted and registered on a separate dial, the pointer remaining fixed at the end of each half-hour, when the mechanism resets itself. Thus no fresh movement of the pointer occurs until the number of revolutions in any half-hour exceeds the first, when the pointer is moved on to register the higher number, and this number multiplied by a constant gives the maximum horse-power taken during the half-hour. The same meter in this way can be made to register the highest rate of using power as well as the total number of units used. A check is thus kept on a customer's demand on the station as well as on the quantity of energy used. Owing to the ability of steam

turbines to carry overloads, and to their great fly wheel momentum, it is less necessary to be particular about short overloads than it was formerly, and there is a growing disposition to adopt simpler forms of tariff, which can now be done with fairness to both sides on the extended experience of power supply in different industries which is now available. New forms of recording wattmeters are also being brought out which act separately from the meter. There is, however, still room for more work in these directions, as satisfactory means of measuring power, and its rate of use, are of much importance in promoting confidence and good understanding between power users and power suppliers, and the inability to obtain satisfactory instruments of these types until recently, has had something to do with progress in power supply not having been more rapid.

Horse-power Employed in Different Industries.

The horse-power employed in different industries varies considerably; for instance, taking the light class of trades such as builders, small mechanics' shops, printers, and the large class of jobbing trades, the horse-power per man employed will be between ¼ and ½. Engineering works will usually take from ½ to 1 horse-power per man. Mines employ on an average about 1½ horse-power per man, varying from less than 1 horse-power per man for the smaller classes of mine to 2 and even 3 horse-power for modern collieries working on a large scale. In the textile industries the average appears to be about 1 horse-power per employee. In industries where there is much grinding, such as milling and cement making, the horse-power is higher, averaging 5 to 6 horse-power per man, and even more in modern plants. Again, in rolling mills, it may be very high, and in large electric power stations will amount to 200 horse-power per man or more. Taking, however, the general run of industries in a district, the power used will not average much over 1 horse-power per man employed; for instance, in London recent statistics show it is a little over ½ horse-power, while in the North, where the trades are much heavier, it will be double or more.

Cost of Power as Compared with Labour in Different Trades.

Now, having regard to the prices for power which have been mentioned above, it will be seen that in the majority of trades the cost of power in comparison with that of the labour employed is comparatively small. For instance, if the cost of power is ¾d. per unit, this is not much above ½d. per horse-power hour, while the wages per employee will perhaps average 6d. per hour or more; thus in the majority of trades the wages are ten to fifteen times the cost of power when this is supplied at the lowest modern prices. While, therefore, power is absolutely essential to the carrying on of nearly all industries, it will be seen that its cost is in most trades not a preponderating factor, though the capital cost of installing it, its proper working and the trouble of looking after it are of great importance. Nevertheless, even at these prices, power supply is a very large business if we consider that the supply in a large industrial area might easily necessitate the installation of 200,000 to 300,000 horse-power of plant, the revenue from which would probably be between £700,000 and £1,000,000 per annum. In addition, however, to supplying the industries of a district, the modern power station should also supply the energy for lighting and tramway supply, and it will have been seen that the power already employed in these two directions is in the neighbourhood of one-sixth of that employed in the industries of the country. It is also probable that, as railway electrification is carried out, a large proportion of the supply will be derived from the power supply stations of the districts through which the lines run. Then, again, there is electric heating, a development which, while only just becoming practical outside a very limited range, bids fair, as energy can be supplied at lower and lower prices, to become a very serious factor. There is thus a great further opening for power supply, though it is necessary to bear in mind that the supply of power to industries, and the price at which they get it, is not quite so fundamental an object as has sometimes been represented.

Advantages of Public Power Supply to Consumers.

Apart from the question of price, there are, however, a number of advantages in taking electric supply from a public source. Besides the saving in the cost of establishing local generating plant, there is the ability to obtain further supplies at short notice; for factory repairs and other similar work only the motors needed require to be run; there is no banking of fires or getting up steam preparatory to work; the risks of breakdown are less, with

chances of quicker execution of repairs, and finally there is the great advantage of regularity of drive. If the power supply comes from a large station where turbines are installed, working at high electrical pressure, both the pressure and the cyclic variation of the current can be kept within very narrow limits, and this, coupled with the special properties of multiphase motors which are almost universally used in power supply, enables an almost constant speed to be maintained. So much is this the case that it is being found possible in practice to speed up many of the machines in factories from 6 per cent. to 15 per cent. when driven by motor, and thus a larger output is secured without further capital expenditure and with but little addition to the labour needed. It is becoming recognised that the *quality* of power is of as much importance as the quantity and price.

This has proved to be the case especially in the textile industries and in the rolling of iron and other metals. It is also found so in engineering shops where work can be turned out at a greater rate, while the regularity of the speed is of importance in securing accuracy.

There are also the more general advantages obtained by the saving of coal, as already mentioned, and by the reduction of smoke in industrial districts, which alone are sufficient to warrant every encouragement being given to the extension of public power supply.

THE PRESENT POSITION.

Such, then, is briefly the present position. The figures given indicate that a larger amount of work has already been done in power supply from public stations than I think most people imagine, but it is also clear that hardly more than one-sixth of the work which there is scope for has been done as yet, especially if the political and legal conditions were such as to enable supplies in each district to be laid out on the best engineering lines.

It is, therefore, important to inquire what these are as far as can be done, bearing in mind that local conditions will in nearly all instances to some extent modify such conclusions, though probably not greatly, since the figures relating to power supply undertakings in different parts of the country which are now becoming available indicate fairly close correspondence.

DRAWBACKS TO PUBLIC POWER SUPPLY.

Power supply from a central source has, of course, some disadvantages and drawbacks to contend with, which must be taken into account as compared with power generated where it is required to be used, and these should always be debited against it as a precaution, and then be compared with its advantages in order to arrive at a correct understanding of the question.

For instance, in public power supply there is the initial handicap that legislative powers must usually be obtained before it can be undertaken, and this always weights the enterprise, especially if private, with an amount of dead capital, which in this country is unfortunately very considerable, and forms a material handicap in the early stages. In the next place, a separate board of directors and management is requisite, while manufacturers as a rule will not debit their own power costs with any material sum under this head, though it is really an item of considerable moment, even if difficult to apportion. Rating and taxes will also be higher for the public supply, and lastly there is the most important item, namely, the distributing system, which, both as regards its capital cost and the running losses which occur in it, is an addition to the generating station costs. A central power station also has the disadvantage that it has usually to be built considerably in advance of the possibility of obtaining the full beneficial use of the plant it contains; therefore capital costs have also to be added in most cases to cover expenses incurred until the station can accumulate sufficient load to pay its way, whereas a manufacturer usually only puts in plant which he is ready to use at once, though it may not be quite to its full capacity. There are a good many reasons, therefore, why a central power supply is not an easy business to start, especially if it is separated from lighting, and has to be begun off the ground, and, consequently it is particularly desirable that such a business should receive encouragement in its early stages, and should not be overloaded with onerous conditions which later on might be borne easily, but which at the commencement may overweight the enterprise altogether.

ADVANTAGES OF POWER SUPPLY—DIVERSITY FACTOR.

Against these drawbacks we have to credit the advantages already mentioned, and also the material gains which can be obtained by centralisation and working on a larger scale. These will be dealt with in detail later.

There are also two general advantages obtained by supplying from a central source

which are very important when the source is of considerable size, and with which it will be best to deal briefly before discussing power supply more in detail, viz., the diversity and load factors. By diversity factor is meant that when a number of separate supplies are grouped together, they are not all taking their maximum amount of power at the same time, and so much is this the case, that it is found in practice that if a large number of small consumers are taken together, the output to supply them all from a central station need not be more than a quarter to one-third of the horse-power to which the separate engines would have amounted if each consumer generated his own supply, and used his maximum power at the same time. In the case of large consumers having a number of motors on their own premises, it is found that the total power they require is seldom more than one-half to one-third the rated horse-power of the motors they have installed. Again finally, when the loads of these larger consumers are averaged at the power station there is a gain of about 30 per cent., and often more, depending on the class of load, so that the diversity factor of large consumers will work out at over two, as a rule, if estimated on the motors installed and their horse-power, and at nearly 1·5 on the maximum loads, treating each consumer, however large, as one unit. In this connection it is becoming very desirable that engineers should agree on a more accurate definition of diversity factor by defining more precisely what is to be taken as the maximum load.

For these reasons, practice shows that on large stations giving supply to miscellaneous industries, two and a-half to three times the output of the station can on an average be installed in motors at consumers' premises. Thus it is only necessary to debit something less than half the capital cost per kilowatt of the station and mains against each kilowatt of motors installed in customers' works.

On the other hand, if we look at the diversity factor as related in the consumers' maximum loads, treating each consumer as one unit, it is probable that the diversity factor regarded from this point of view will not increase much with the growth in size of power supply, as a larger proportion of consumers having many motors will be taken on who will have already averaged the maxima of the motors in their own works.

Load Factor.

Our next point is the load factor, that is, the amount of energy supplied from a station as compared with what would be supplied by the station if it was working continuously all the year round at the maximum load supplied by it; it is, in fact, the ratio of what is actually got out of the plant brought into use as compared with what could be got out of it under the most favourable circumstances.

From what has already been said of the diversity factor it will be apparent that the load on the central station will be much less than at individual works. For instance, it is found that the smaller classes of power consumers usually use their motors to an extent which represents less than 10 per cent. of the rated output for the hours of work, and often it is only half this. When we come to larger works employing several motors the load factor will rise to 16 per cent. or 18 per cent., and in considerable manufacturing works it is probably as an average something under 25 per cent. For textile mills the load factor will again be better and when we come to works operating all night, the load factor may reach 60 per cent. or more, while for electro-chemical work it is between 80 or 90 per cent. usually. Although the average time of employment of motors is in the majority of instances comparatively short, they are liable to be operated any time during the working hours, but owing to the diversity factor their loads are spread out, and thus the load factor in the central station is far better than the average of that of the consumers. Again, a large power-supply station will, as a rule, be able to average its customers better than a smaller one, and thus will secure a better load factor. This means that the working costs per unit in the larger stations, which are for the most part nearly constant in a station, except in the item of coal, can be spread over a greater number of units, and are thus correspondingly reduced.

As between smaller and larger stations it is somewhat difficult to define what the increase of load factor will be as it will depend on the trades in the district, but it may be fairly put that if the load factor of a 2,500 kilowatt station is 26 per cent., that of a 40,000 kilowatt station operating under similar circumstances would probably be 35 per cent. at least, and not improbably more, as the larger station will have a much larger proportion of customers of considerable size, whose own loads would be better. This means an improvement of over 30 per cent., and if we take the extra coal used for the longer working load and allow for other items of increased cost, it still means a saving

of about 10 per cent. in the working costs owing to this fact alone, which is an important item. Later on we shall have occasion to refer to special methods of improving the load factor.

HOME INDUSTRIES.

The Crisis in the Coal Trade.—Most happily, the Conciliation Board for the South Wales coal trade seem to have arrived at a settlement of the dispute which threatened to involve the whole of the collieries of the United Kingdom. The Eight Hours' Act came into operation on July 1, and the coal owners had given notices which expired on the night of June 30, so that they might be able to insist upon a fresh system of working in the altered cases. As previously explained in these Notes, their chief demand was that they should be at liberty to order double shifts when they thought fit. With that conceded, settlement of the general dispute was always in view. It was not very easy to understand the men's objection, seeing that the system works well elsewhere, but the difficulty has been got over by the owners agreeing to the miners' proposal that all such proposed changes shall be submitted to them for consideration before adoption, and that all objections to any such new methods shall be submitted to the Conciliation Board for decision. But this is subject to an undertaking being given by miners' leaders to raise no obstacles to new methods of working when their introduction into particular collieries has been agreed to locally. Another somewhat serious point of contention was the owners' demand that the men must work the sixty extra hours per year which the Act allows. It is agreed that this question shall be tested by taking a case to a court of law. The question at issue here is in essence one for the interpretation of the courts to settle, and the entire community is to be congratulated upon owners and miners having had the good sense to appreciate this.

Short Time in Cotton Mills.—The ballot shows that a majority of the Master Spinners' Federation who spin American cotton are in favour of organised short time for most of the next three months. The mills of the Federation, and as many of those of outsiders as can be induced to join, will close on Saturdays and Mondays from the middle of this month to the end of September. Spinners have been losing money on staple counts of yarn for some time, and though most of them are still paying dividends of 10 per cent., they are not earning them, the payments coming from reserve funds, and they can hardly last very much longer if drawn upon to the same extent. The reports as to the condition of the new cotton crop issued by the United States Department of Agriculture are less favourable, and though there is no cause to fear a cotton famine, it is probable that cotton prices may remain for some time too high for any large buying by the chief markets. In these circumstances some limitation of the output would seem to be necessary, and, indeed, there has been a good deal of voluntary short time in the spinning trade for some time past.

Gas v. Electricity.—Two or three years ago it was argued at some length in these Notes that as an illuminant gas was likely to be a much more formidable rival of electricity than was generally supposed, and therefore the prevailing assumption that electricity must oust gas was by no means demonstrable. It was contended that as to convenience, there was little to choose between the two, since by means of a by-pass on the burner instantaneous light without the aid of matches can be secured by gas, whilst in the matter of cost the advantage was decidedly with gas. Since then the comparative advantages of gas have become much more apparent to the ordinary consumer. It is not only that gas may be as convenient and is much cheaper, it is more dependable. Breakdowns with electricity, over the whole supply as well as individual cases, are not uncommon, but with gas there is no such irritating possibility. From whatever point of view the comparison is made between gas and electricity, except perhaps in the matter of cleanliness, the former holds its own, whilst the saving in cost is very great. It may be safely said that, speaking generally, electricity is twice as expensive as gas, and under certain conditions the ratio is even higher. The present position of the rival illuminants is in striking contrast to what it would have been if the predictions of the experts a few years ago had been fulfilled. Many gas consumers were frightened into the belief that the gas companies would soon be within sight of bankruptcy; their outlook to-day is much brighter than ever it was. This, of course, is largely due to the rapidity with which gas is now superseding coal as a heating agent. It is more convenient in every way, and with the substitution of gas for coal, the atmosphere of great towns, and more especially London, must be immensely improved.

Railways and the Land Clauses.—It is understood that the railway companies have received satisfactory assurances from the Chancellor of the Exchequer as to exemption from the taxes on undeveloped lands and minerals. It would be eminently unfair to impose such taxation. The unused lands of the railway companies were bought and paid for, always at a high price, just as the other lands bought by the railway companies were purchased, for railway purposes, and it does not alter the position that all of them have not hitherto been used for such purposes. Moreover, railway companies do not work the minerals under their land, because, for one reason, they require the support of the underlying ground for their traffic.

Banking Profits.—The one or two bank dividends announced at the time this Note is written tend to confirm the expectation that the past half-year would

show rather unfavourable results. A rough test is afforded by what is called the "profit margin,"—that is, the difference between the interest paid to the depositor and the amount the bank obtains by investing its money in bills. For the six months to June last the average rate for three months bank bills was £1 17s. 9d. per cent., and the average rate allowed to depositors £1 4s. 3d. per cent., which shows a margin of profit of 13s. 6d. per cent. This compares with 15s. per cent. in the second half of last year, with 18s. 6d. in the first half of 1908, and with £1 11s. in the second half of 1907. The average rate for day by day money was a little under 2 per cent. against nearly £2 15s. per cent. in the first half of 1908, and the average rate obtained for loans to the Stock Exchange was a little under 3 per cent. against 3¾ per cent. last year.

The Shipping Trade.—The outlook for freights is better than it has been for some time past, although the conditions, especially in the North Atlantic, are still anything but good. In their review of the shipping trade of the past six months, Messrs. H. E. Moss and Co., of Liverpool, say that modern tramp steamers can now be worked so as at least to earn interest and depreciation, which is more than could be done for some time past. The tonnage laid up has been reduced to less than one-half, and that remaining idle is practically out of date. Messrs. Moss and Co. estimate the amount of obsolete steam tonnage at fully one million tons. The prices for building steamers were never lower, mainly through the improved means of construction builders have now adopted. New steamers, with 6,000 to 8,000 tons, with fair specifications, can now be placed at about £5 5s. per ton on the dead weight, and other sizes in proportion. Most of the new steamers left on builders' hands two years ago have been disposed of, and the majority of bargains in the way of comparatively new steamers have been picked up. Indeed, throughout the recent crisis there were very few forced sales, which proves that the bulk of shipping is held in much stronger hands than formerly. Second-hand steamers have been difficult to sell, the depreciation of this class of property being much greater than that of new tonnage.

Wheat Supplies. — The indications continue to point to the present price of wheat being not only maintained but exceeded in the coming months. The high prices of the spring led to some farmers selling their crops with unusual freedom in the first half of the season, and the same remark applies to Germany. That country requires about nine million quarters of foreign wheat to meet its requirements, but only five million quarters were imported net in the first ten months of the season ended May. Our own requirements of foreign wheat for the season may be put at twenty-seven million quarters, but up to May 31 only 19,227,000 quarters had been imported, so that about 7,500,000 remain to be imported before the end of July, whereas last year 3,920,000 quarters were found to be sufficient. Thus between them Germany and England require to import between 11,000,000 and 12,000,000 quarters in the two months ended July. On the other hand, the world's visible supply on July 1 was only 9,050,000 quarters as compared with 9,835,000 quarters in 1908 and 16,680,000 quarters in 1907. Of course much will depend upon the coming harvest, but if reports are to be relied upon, at best it is not likely to be better than an average one. No doubt high prices have induced economy in the use of wheat, but there must be much greater economy, both in this country and in Germany, or else a more extensive use of substitutes before the new wheat becomes available. But in any circumstances, and remembering that the "invisible" supplies of wheat this year are smaller than they have been for many years past, high prices for wheat must be reckoned with for a considerable time to come.

Coalite.—Two or three years ago considerable interest was shown in "Coalite." A company with large capital was formed to work it, and great results were promised. As so often happens, experience has not borne out the confident predictions of inventors and promoters. A circular has recently been forwarded to the shareholders of the company which purports to explain the present position, and shows how expectations have been disappointed. In commending coalite to the public particular stress was laid upon the fact that in its manufacture the ultimate object was not the production of gas or tar, but of fuel, and that the residue in the retort, which in the manufacture of gas was only a by-product, was in the manufacture of coalite raised to the rank of the staple manufacture. Now coalite is officially reduced to the rank of a by-product like ordinary coke in gas-works. The directors state that they expect to derive their chief profits from the distillation of tar. It was claimed, again, that coalite required hardly any draught to burn, but it now appears that at Plymouth slow-combustion grates have to be used, and that in open-draught grates a certain method had to be adopted to make them consume coal economically. It was anticipated by the promoters of coalite that, being more economical than coal, it would replace the latter for steam-raising purposes, and that it would be the fuel of the future for the navy. The circular is silent upon these expectations, and there is nothing to show that they have been, or are likely to be, realised.

OBITUARY.

LIEUT.-COL. SIR WILLIAM HUTT CURZON WYLLIE, K.C.I.E., C.V.O.—The whole country was shocked and horror-stricken to learn of the assassination of Sir Curzon Wyllie, which took place

at the Imperial Institute on the night of the 1st inst. As full details of the crime have appeared in the press, there is no need to record them here.

Sir Curzon Wyllie was the youngest son of the late General Sir William Wyllie, G.C.B. He was born in Cheltenham in 1848, and after being educated at Marlborough and the Royal Military College at Sandhurst, in 1866 he joined the 106th Regiment as ensign. Thirteen years later he was transferred to the Political Department, and served in Baluchistan under the late Sir Robert Sandeman during the Afghan War in 1879-80. He was also chosen to accompany General Sir Robert Phayre's force to the relief of Kandahar, carrying despatches, for which he received the medal.

Among his many activities as a servant of the State in India he was also military secretary to his brother-in-law, the late Right Hon. W. P. Adam, Governor of Madras, in 1881. He was also private secretary to Mr. Hudleston, who acted for a few months as Governor on the death of Mr. Adam. Other positions successively held by him were those of Resident in Nepal, Governor-General's Agent in Central India, and Governor-General's Agent in Rajputana. On his retirement as Lieutenant-Colonel in 1901 he was appointed Political A.D.C. to the Secretary of State for India, a position which gave him many opportunities of helping Indians resident in London. His kindness of heart and genial courtesy gained him many friends, both Eastern and English; and the assassin's act deprived young Indians visiting London of one of their best and kindest advisers.

For his various services Sir Curzon received many distinctions, including the C.I.E. in 1881, the K.C.I.E. in 1902, and the C.V.O. in 1907.

Sir Curzon became a member of the Royal Society of Arts in 1907, and at the time of his death was serving on the Committee of the Indian Section, in the work of which he was deeply interested.

QUESTIONS AND ANSWERS.

Readers in search of information which cannot be obtained from the usual sources are invited to make their wants known in the *Journal*, in the hope that they may be assisted in their difficulties by their fellow members.

On all communications must be written the name and address of the sender, not necessarily for publication, but as a guarantee of good faith.

Each question or reply should be written on a separate sheet of paper, and should bear such signature of the writer, and such address as he wishes to appear.

Questions which can be answered from the usual books of reference, will not be printed.

QUESTION.

TREATMENT OF SLAG FROM THE CUPOLA IN GENERAL FOUNDRIES.—What is the best method of recovering iron from the slag? I generally return the coke and slag adhering to it to the cupola, but is the "fluid" slag run off at the end of the day worth treating? I understand machinery has been used for grinding and washing slag for the recovery of iron, but it does not seem to be in general use; so far I have only come across two instances. What would be percentage of iron in the "fluid" slag run off, and is there a machine that would pay for treating this?—J. H. H.

GENERAL NOTES.

THE COST OF A PAUPER.—In the Statistical Memoranda and Chart just issued by the Local Government Board, relating to public health and social conditions, there are some interesting figures bearing upon the average annual cost of an indoor and out-door pauper, the comparison being between that of the years 1856-7 and 1906-7. The figures relating to 1906-7 may be taken as accurate, but for the earlier years they are approximate only. They work out as follows:—

	1856-7. Cost per head (approx.).		1906-7. Cost per head.
To paupers in Poor-law institutions	£16 12	..	£29 5
To paupers in receipt of out-relief	4 13	..	7 1

The total cost has increased from £5,521,000 to £11,559,000; the average cost for indoor paupers has increased 75 per cent., and for out-door paupers 52 per cent. The sick and infirm need more elaborate treatment than do the able-bodied poor, and the relative increase of this class of poor has been accompanied by provision for their accommodation and treatment in special wards or institutions on the lines demanded by the development of medical and surgical practice. The accommodation for children in separate institutions, and the necessary appointment of a suitable staff for their management, have equally involved an additional heavy expenditure. The bare comparison of the cost per pauper over a period of fifty years conceals both the change in the character of the persons dealt with by the Poor-law, and the specialisation of treatment which accounts for the increase in the cost of their relief. The higher rate of relief to out-door poor is largely explained by the fact that in contrast with the practice half a century ago out-relief is now largely limited to the class of aged and infirm, who are permanently or semi-permanently disabled. It has thus become possible to grant relief on a scale more nearly adequate than formerly.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE PUBLIC SUPPLY OF ELECTRIC POWER.

By G. L. Addenbrooke, M.I.E.E.

PART II.*

Capital Cost of Electric Power Stations.

After having outlined the general position we now come more directly to the consideration of power supply undertakings in themselves. For this purpose we will first deal with the capital cost of creating public supply undertakings, and then with their working costs, showing approximately how these vary with varying conditions, and as the size of the undertaking is increased. Various attempts have been made to do this by different engineers in papers and in the technical press by means of curves, but the lecturer has found in his personal experience that the best grasp of the subject is obtained by inspection of a set of Tables such as those now given. These have been deduced from data in the lecturer's possession, and compared with figures which have been put forward from time to time by other engineers.

The lecturer puts these Tables forward with some diffidence: they must in no sense be considered as a ready-made guide to power station practice. Experience shows that when any practical work is undertaken there will always be local circumstances and conditions which will make each project unique in itself and result in a considerable variation from a standard favourable or otherwise, besides the fact that such undertakings are usually built up by steps and are not evolved as a working whole at once. Nevertheless, such Tables are useful because they bring most of the facts before us in a concrete form and in a way which enables us to estimate the relation of each item to the whole, and what is of even more importance, the extent to which variations in one or more items will affect the whole.

They are in fact to be looked on as equations in which the quantities involved in the supply of electric energy are represented by their most likely values for each size of undertaking, though there may be considerable variations in any or all of the items under special circumstances.

It is particularly necessary to bear this in mind, because owing to electric power supply in this country being partly established as an independent industry and partly being financed by money borrowed at low rates of interest on the public credit, two different bases of value are created, and this greatly complicates any comparative treatment of the subject. What I have done is to prepare the Tables on the assumption of the industry being self-supporting, which is the sound economic basis. The variations and reductions obtained by financing with public funds at a low rate of interest are, then, a measure of the support which the Government and local authorities are giving by borrowing on the credit of their other assets. (See Table, p. 712).

Capacity of Stations.

First, as regards the capacity of the stations, the sizes given are intended to represent the actual output of the stations, so that the plant installed can be taken as one-third for the smaller sizes to one-fourth for the larger, more than that shown. For a permanent plant which is not going to be enlarged, the convenient way is to divide it up into eight units, of which two would form the reserve. In

* The Course consisted of three lectures, delivered on January 18 and 25, and February 1. In re-arranging the material for publication, the lecturer has preferred to divide it into four parts.

stations in a district where the load is likely to grow, however, it is usual to instal larger sets than this would imply during the initial stages, and to trust to the overload capacity of the generators to tide over any difficulty should more than one set be out of commission at a time.

The chief feature of this Table is the reduction in the capital cost, according to present practice, per kilowatt; as the size of stations is increased, this reduction, it will be noticed, is progressively less as the larger stations are reached. At present there is probably not much gain by going further in size, though several stations already of greater capacity than the largest given in the tables have been built. The capital costs of power stations are now well ascertained, and those given will be found to agree closely with work which has been carried out and with the estimates of the price which a simple works plant of 300 to 500 horse-power could be erected for without spares or coal and labour-saving refinements. It is, however, seldom that a works can hit off the exact amount of power it requires, there must usually be some margin, and even if no spare steam or electric plant is installed it is necessary to have spare boilers, so that altogether the cost of private plant of this size will be above the cost of the smallest central plant given. For still smaller private plants the costs will of course be higher again per kilowatt.

With the spare plant provided in the above stations there would be no difficulty in maintaining absolute continuity of supply under all circumstances, whereas a private plant without spares must inevitably have an occasional shut down.

I.—Approximate Capital Costs of Electric Power Supply Undertakings.

Available output of station K.W.S.	Cost of power-house per K.W. available.	Allowance for distribution system per K.W.	Parliamentary expenses, cost of finance and working capital, per K.W.	Total costs per K.W. available.	Capital cost of undertaking.
	£	£	£	£	£
2,500	24	20	12	56	140,000
5,000	20	16	10	46	230,000
10,000	17	14	8	39	390,000
20,000	15	12	6	33	660,000
40,000	14	10	5	29	1,160,000

One kilowatt equals 1⅓ horse-power nearly.

other engineers. It is well to note that in the largest size of station in the Table there is nothing outside everyday practice, as several of the large towns—and power companies—are now having installed steam turbines of 5,000 to 6,000 kilowatts capacity, the price of these being about £4 per kilowatt including the dynamo and requisite condensing plant, and erection, this sum being about one-third of what was paid a few years ago for large slow-speed reciprocating sets to do similar work.

The figures shown are conservative, and it must also be recollected that there is a continual tendency for the price of plant to fall. In fact since the figures were prepared there has been such a reduction in prices, and under favourable circumstances and with cheap buildings the figures given could at present probably be reduced 10 to 15 per cent. The highest of these costs comes to about £16 per kilowatt of plant installed, and this is about

Distribution.

A proper figure to cover this is always a vexed question with engineers; the figures given in the Table are, however, borne out in practice, for the smaller sizes and the larger have been carefully estimated and agree with figures arrived at by other engineers. In the smaller stations the distribution is assumed to be up to about six miles from the station, and in the larger up to eight or ten, or a little further on favourable routes. These figures do not include costs of local distribution for lighting or of sub-stations for transformation of the alternating to a continuous current for tramway or railway supply. Out of the costs about £4 per kilowatt will be for transformers and switch gear in the smaller networks and about £3 in the larger, the remainder of the costs being for cables, laying, jointing, joint boxes and sub-stations.

The reason for the fall in the cost as the size

of the system increases is that the smaller stations cannot supply current so cheaply as the larger ones and therefore can only deal with customers up to certain sizes, and so have to go further for their custom on an average and also employ smaller cables. For instance, it is in power supply work a good rule to bear in mind that for a central supply to be able to deal advantageously with consumers, as compared with the costs at which they can make their own power, the largest customer should not exceed in size one-tenth the capacity of the station serving him, and it is better to keep within this ratio if the distance of transmission is long. Until this proportion is reached the special charges which the central station has to bear will often offset the gains of economy in other directions. The cost of laying the classes of cable used in this work are very much the same whatever size is used, and the cost of the cable itself by no means increases proportionately as the section is larger. The following data will show this for sizes of cables which are much used on the 11,000 volt distributions which are usual in this country:—

Section of cable.	Approximate carrying capacity kilowatts, up to	Cost laid per mile.	Cost per kil. Capacity per mile.
		£	s. d.
·05 sq. in.	750	900	22 0
·10 ,,	1,500	1,200	16 0
·20 ,,	3,000	1,700	10 6

It is also the case that the smallest sizes of branch cables which are laid to works have usually a much greater capacity than they are used for, and this will be much less the case with large distributing systems where the price of current is low and it is taken in greater quantities. The cost per kilowatt of transformers and switch gear is also very much less for larger supplies, especially switch gear, which is almost a standard pattern for such work as is found in sub-stations and in consumers' premises. It is probable that in practice the cost of the distributing systems for the larger undertakings will usually be greater in practice than is shown, because there will be a tendency to extend into the less profitable and more distant parts of the area, charging rather higher prices for supply to balance the increased capital cost, but this is a development which will rest on its own basis and does not affect the accuracy of the figures in representing the lowering in cost from increased scale of working, and the actual costs which are likely to be incurred in the disposing of the amount of energy mentioned within the more central parts of the better industrial area of the United Kingdom.

Preliminary Costs and Finance.

We now come to an item which may differ largely in different cases; that for preliminary costs, costs of finance and working capital, together with all those other extraneous items which have to be met in establishing a business. Unfortunately in this country the costs to private promoters of obtaining Parliamentary powers for an undertaking of the kind we are discussing are heavy, and not only is there this expense but there will in most cases be in addition long negotiations with local authorities, which always means having to pay the costs of both sides in some form or other. The cost of finance is also considerable in starting new undertakings, and in the lecturer's experience there are always a number of expenses in the early stages of all undertakings which must be met, but which cannot be brought under either of the two previous headings. For instance, even corporation loans are often raised at a discount, and there are the expenses of raising them, which must be debited somewhere, and heavy cost has sometimes to be incurred for the purchase of land; then there is the working capital of the business, and often interest on capital to be paid before the undertaking comes to fruition.

As power-supply undertakings increase in size and become paying propositions promoters will be able to raise money more and more cheaply, but I have still debited a considerable sum of extraneous expenditure under the head, as when an undertaking of this kind grows to large dimensions it often has to buy out smaller stations or compensate them in some way by doing unremunerative work, such as lighting poorer districts. As an instance, I may mention the Newcastle company as having already shut down 11 small stations, scrapping capital value of nearly £300,000. This is an important point for those interested in industrial districts to bear in mind; if the smaller stations are allowed to increase unduly and then have to be scrapped, and if comprehensive schemes are not initiated in time, it may result in both local authorities and companies being out of much of the field of power supply, and at the

same time prevent as cheap and efficient a service being given to manufacturers as could otherwise have been arranged. Altogether, therefore, the figures put in this column are in accord with facts, though I must confess that, for the benefit of power and light consumers, it would be a very good thing if they were less, and this could be accomplished to a considerable extent if electrical enterprise were treated with more consideration and encouragement in this country.

The last column shows the total capital which will approximately be needed for each size of undertaking.

We now come to the working costs of such stations, to investigate which we must first agree on certain working data which are set out in Table. II.

Station Working Data.

The load factors are taken at the figures mentioned in the first lecture as those most likely to be obtained. For pure power supply they are I think unduly conservative, which makes the average prices given later rather higher than they would turn out in practice; but few stations will exist any length of time without supplying a good deal of current for lighting, which raises the average price and lowers the load factor. It should also be noted here that several of the power companies are now supplying current for electrolytic and similar long hour work to factories situated close to them. The working hours for this class of load being nearly the maximum possible, this secures more constant work for the plant and spreads out the capital and other charges over a much greater output, enabling a general reduction of prices to be made.

The number of units sold follows from the load factor. The lbs. of coal used per unit of energy sold have in each case been deduced from the best modern practice.

Usually speaking, when we come to deal with such small quantities of coal, the number of British thermal units used should be quoted instead of the lbs. of coal, as it is on the number of British thermal units in the coal that its steam raising power chiefly depends.

Take the class of coal assumed to be used as giving 11,500 to 12,000 British thermal units per lb. On an average the largest station will use 38,000 to 40,000 British thermal units to supply a customer with one Board of Trade unit. Thus it results that the overall efficiency of the plant from the coal to the consumer is a little over 8½ per cent. in the larger stations. For the 2,500 kilowatt station the overall efficiency is about 6 per cent. This is up to the consumers' motor terminals, and does not include the losses in the motors themselves, which would probably bring down the overall efficiencies to 7½ and 5½ per cent. respectively.

The price of coal assumed is about that paid by power stations in industrial districts for the class of coal they use in normal times, and from the way the tables are made up, it is easy to see the effect of any alteration, either in the quantity used per unit sold or in its price. For instance, the cost of carriage to London adds about 6s. per ton to the cost of coal in the coal-mining districts. These figures will also be very useful when we come to consider the possibilities in the substitution of gas engines for steam engines or turbines, on the use of which latter it need hardly be said the Table is made up.

II.—Station Working Data.

Available output of station K.W.S.	Load factor.	Sold to customers per annum.	lbs. of coal per unit sold.	Coal cost per unit sold at 6/8 per ton.
	Per cent.	B.T.U.	lbs.	d.
2,500	26	5,700,000	5·25	·188
5,000	28	12,200,000	4·50	·160
10,000	30	27,000,000	4·00	·143
20,000	32	54,000,000	3·50	·126
40,000	34	116,000,000	3·25	·116

Annual Working Expenses.

The sums set down for administration and labour have in the smaller cases been taken from the lecturer's experience and from practice; in the cases of the large plants the items have been arrived at after careful consideration; for instance, take the 40,000 kilowatt station, the administration charged in

the Table is in excess of that incurred at Manchester according to their last accounts. It is true that the maximum load at Manchester was only 28,000 kilowatts, but it is an old and scattered undertaking in many respects, and the charges also include looking after the lighting and also after tramway sub-stations, for which an extra price is obtained. Such work is not included in the costs in these Tables as it differs so much in different cases, nor is the cost of a canvassing staff, which is in a large measure a capital charge. In practice also work will be done for consumers, but this should take care of itself. The working costs in these Tables cover transformation of the multiphase high pressure current to any suitable working pressure, and its supply to manufacturers or others, or to sub-stations for lighting or tramway supply, but the costs of distributing the energy through local mains for lighting, or the costs of transformation from alternating to continuous current, are intended to be dealt with separately.

III.—Annual Working Expenses.

Available output of station K.W.S.	Administration and labour.	Coals 6/8 per ton, oil, water, and stores.	Rent, rates, taxes, and insurance.	Repairs and maintenance.	Total costs.	Cost per unit.
	£	£	£	£	£	d.
2,500	4,200	4,900	1,500	2,500	13,100	·550
5,200	6,500	8,900	3,000	4,000	22,400	·440
10,000	11,000	16,000	6,000	7,500	40,000	·360
20,000	18,000	30,000	12,000	12,000	72,000	·320
40,000	30,000	60,000	24,000	22,000	136,000	·280

It may be mentioned that the costs of administration and labour respectively are not far from equal in most cases. The cost of labour allowed is less than in the case of the Manchester undertaking, but it has been carefully compared with the work and estimates of other engineers for modern stations, and assuming that most of the energy is sold in fairly considerable quantities. The fall in the costs per kilowatt output of plant, as the size of the undertaking increases, is very remarkable, but is borne out by results already attained. In a power station the attendance needed is rather governed by the number of moving or working parts than by their size. For instance, the smallest size of station in the Table will need turbines and dynamos of 500 to 750 kilowatts capacity, while the largest would probably be fitted with 6,000 kilowatt sets, which are the largest size now being regularly made. But each of these plants has to all intents and purposes the same number of working parts, such as governor, bearings, pumps, exciter, &c., together with the various indicators, gauges, &c., which have to be watched to control the working of the plant, and it is very nearly as much trouble to maintain the smaller plant under observation and perform the various adjustments which have to be made to keep everything going properly, as to do this for the largest set. The same reasoning applies to the boiler-house, though not quite to the same degree. Again with the distributing system, if we double the output, we shall not have to double the length of mains, or the number of consumers, at the larger output the price will be less, and larger consumers will be obtained, and on an average at shorter distances along the mains, moreover few organisations need to be doubled to do double the work. Altogether, therefore, it is clear that the gains by consolidation, shown in the Table, are moderate, and may even be exceeded in practice.

The question of coal consumption has already been mentioned, and will be dealt with later on, when we come to discuss technical points.

Rent, rates, taxes, and insurance are rather debatable items, but the sums allowed have been fixed after careful consideration of the similar costs in existing undertakings.

The amount allowed for repairs and maintenance averages nearly 2½ per cent. on the value of the plant. New plants will be able to do with a much smaller allowance, but it is assumed that the plants we are considering have been in use long enough to need the average amount of repairs; this is irrespective of the sums which are allowed for depreciation later, and which amount to three per cent. on the capital expended. As cable makers will agree to maintain distributing systems for one per cent. on their cost, and buildings, and a good deal of other works do not need much

maintenance this leaves a very substantial sum for these parts of the plant which do need a good deal of renewal, and the antiquation of which must be provided for.

Total Cost per Unit.

With these various items before us, we can now estimate the total costs per unit of supplying energy including all expenses, except interest on capital and depreciation, and the figures will be found instructive. It will be observed that, commencing at rather over a half-penny per unit sold, as the scale of operation is increased the costs come down to a little over a farthing per unit sold, or to one-half, and notwithstanding this reduction, it will be found on inspection that the allowances are really more liberal for the larger stations than for the smaller.

In work by local authorities the allowance for interest and sinking fund under this head is often not more than 6 to 6½ per cent., but my convinced opinion is that when all is said and done power supply is and must remain for a good many years at any rate a trading adventure, a very legitimate one and one likely to be sound and successful in the long run, but, nevertheless, one which ought to carry an all round profit of at least 5 per cent. If corporations embark on the work with the intention of working on a less margin of profit they are mortgaging their other assets for at least the difference.

It will be noticed that this 9 per cent. amounts in the aggregate to very nearly as much as the total working costs, and it is a point worth carefully noting as a feature of this class of work, that subject to a certain amount of variation, there is a general tendency for a fair interest and depreciation on the capital involved to amount to as much or nearly so as the other total annual costs and charges.

IV.—Revenue and Selling Price.

Available output of station K.W.S.	Total costs, as above.	6 %, interest, 3 % depreciation on capital.	Total revenue.	Average selling price per unit.	Private supply, same size.
	£	£	£	d.	d.
2,500	13,100	12,600	25,700	1·10	·68
5,000	22,400	20,700	43,100	·85	·51
10,000	40,000	35,100	75,100	·67	·40
20,000	72,000	59,400	131,400	·58	·35
40,000	136,000	194,000	240,400	·50	·30

Expenditure and Revenue.

In this Table the total costs are brought forward from the last table. In the second column we have figures representing 9 per cent. on the total capitals of the different undertakings as shown in the last column of Table I. This 9 per cent. represents an average interest of 6 per cent. on the total capital shown, and 3 per cent. for depreciation, reserve and contingencies, also on the whole capital. This is rather a full allowance, but I have taken into account that stations are usually built up gradually and therefore may on an average cost somewhat more than is shown on the Tables for each size, and this allowance capitalised would also permit a somewhat larger sum being spent on the distributing systems without crippling the undertaking financially; it is also a point that expenditure on the distributing system has to a considerable extent to precede the earning of revenue, and therefore undertakings have often to carry for two or three years extra expenditure on the distributing system before they become properly remunerative.

With these figures we are in a position to set down the gross revenue which each undertaking ought to earn, and finally in the last column the average price per unit sold which should be obtained, the number of units being those given in Table II., together with the average load factor there stated.

In this last column we get the whole situation summed up, and can see what can be done by each of the different undertakings. It will be noticed that there is roughly a difference of over 50 per cent. in favour of the largest undertaking, and nearly that for the 20,000 kilowatt station, which is probably the more practical one to compare with. Although there are in the country a certain number of places which will ultimately warrant the erection of stations containing over 40,000 kilowatts, having regard to the nature of most of the industrial and more populous districts of

the country, the lecturer thinks that 20,000 to 25,000 kilowatts output is likely to be the type of station it will within the next 10 or 15 years pay best to erect, duplicating such stations with interconnecting mains in any district where more may be needed, but working these in the same district in parallel, under the same organisation, and arranging for them all to feed into the same network of distributing mains.

At present stations up to the size we are discussing can be designed and operated as one working unit comfortably, but to go much further than this becomes little more than duplication, when the advantages of using the same site are less, especially if by going six or eight miles off and building another station, most of the advantages of the larger station can be secured and a good deal of transmission be saved. Two such stations can be arranged to work in parallel by means of an interconnecting main, and can practically be operated nearly as one station. This is being done now on a large scale in the Newcastle district and in a number of places on the Continent.

Let us now consider these cost figures more in detail. They are of course average figures and not exactly the figures which would be charged to customers. From the smallest of these stations, energy for lighting would be sold in bulk at, say, 1½d. per unit, and the smaller classes of motors would be charged about the same price. Although, however, the average load factor may not be more than 26 per cent., yet most of the power work will be spread over a time represented by 35 per cent. and thus, as already mentioned, it will be possible to charge consumers of this class taking fair quantities of power and having fair load factors, lower prices than the average shown, especially if they can be reached without too great length of main. Probably in the case of the smallest size of plant we are considering such consumers might be charged about ·85d. per unit to ·9d. while still producing the financial results set out in the Table. If a smaller interest on the capital is taken and preliminary expenses are less, some further reduction in the charges can be made, and this is being very generally done at present in stations started on the scale but built under the expectation of ultimately attaining a much larger load. Still the general result is to confirm the opinion that a station of 2,500 kilowatts is small for giving power supply in a district where the average private plants are of considerable size. Adopting the same reasoning as above in the case of the 5,000, 10,000 and 20,000 plants, it will be seen what a very great advantage they have in these respects.

For energy taken during long hours it will be readily apparent from the Tables how much cheaper this can be supplied while still earning the same rate of profit. The capital charges to commence with are not increased but can be spread over say three times the number of units sold, the same applies to administration, rates and taxes, and labour, only additional stoking being required in a station which must under any circumstances be kept in operation continuously. The coal is increased, but as there are no more stand-by losses, about twice the quantity of coal will suffice to generate three times the number of units; roughly speaking, therefore, for nearly continuous loads, such as pumping, half the prices shown in the Tables will be remunerative.

Again, if the point of supply is near to a single consumer for a large quantity so that administrative and distribution and capital costs are reduced to a minimum, while the maximum efficiency in generation is secured, inspection of these Tables, and making the proper allowances will show how from large plants current for electrolytic and similar purposes can be profitably furnished in suitable localities for a price of as little as ·2d. per unit, and for even less, as was mentioned before.

Comparative Costs of Private Supply.

Not, however, to press the matter so far, let us use these Tables to ascertain the cost of private supply to a large manufacturer who chose to erect his own plant. Taking the smallest size of station in the Table the capital cost will be but little more than for the plant alone. Administration and labour will be reduced to about half the sum in the Tables. Coal will be say 10 per cent. less, rates and taxes, &c., will probably not be more than half. Repairs will be about three-fourths the sum allowed in the Table. If we leave the rate of interest and depreciation the same, which is in favour of the private supply, it will be found that for an average load factor of 26 per cent. the cost will come out at about ·68d. per unit, instead of 1·1d., and this agrees with published results for modern plants. Manufacturers frequently state that they are getting better results than this, but if they fairly debit themselves with the items

they ought to, these results will be found very near the truth.

It is also true that in cases where the conditions are more favourable than has been assumed in the Table, power can be supplied at some average price between those mentioned above for private supply and those given in the Tables for public supply. It is also worth noting that the cost of private supply is about that from a public station four times the size with distributing system and separate administration.

In the paper read by Mr. F. C. Snell on this subject last session before the Institution of Electrical Engineeers, the result for two plants of about 1,000 horse-power each which had been taken over for some time was given, in the first case where the plant was an up-to-date one in all respects, the costs came to ·71d. per unit and in the second case where the plant was not so well-designed the costs were ·97d. per unit. In neither of these two cases were the plants probably debited with the full amounts for rates and taxes and administration (which in equity should have been done) and in the first case the plant being a new one the repairs would be less than the average; if we make a little allowance in these respects it will be closely correct to say that a private plant of about 1,000 horse-power can, with coal at a favourable price, generate energy for itself for about ·75d. per unit at a load factor of 25 per cent. and proportionally cheaper for higher load factors. For plants of smaller size the costs must necessarily be higher. If now we look at the prices for central supply as given in the Tables, it will be seen that a station of 10,000 kilowatt size can very well compete on a bare cost basis for supply for such plants and of course with a better margin for everything of less size; as a matter of fact in nearly all industrial districts the average horse-power for industrial works will be far below 1,000 horse-power.

General Considerations.

Enough has now been said to enable anyone interested to form an intelligent conception of this portion of the subject and to show how the general figures given may be applied with the requisite modification to fit particular cases.

The subject is of the more importance because although we have considered it from the point of view of power supply chiefly, as in fact it has been considered and dealt with by Parliament, yet now power supply is intimately connected with lighting supply also, since it is found that working with large plants at high pressures for transmission it is quite practicable to supply good lighting and also heating from the power supply mains, and one source of supply should be used for all these purposes. At present in many cases power supply is being given from small lighting stations and the lighting is being made to bear the overhead and other costs to an undue extent, but later on if power and light supply can be consolidated properly the one should greatly help the other, and energy could be supplied for lighting and for heating from the joint mains at much lower prices than if the two supplies are separated.

Finally, in case objection should be taken to the capital cost allowed for the distributing system, I would point out that if the price of energy is increased 10 per cent. on the 40,000 kilowatt station, about £8 more per kilowatt could be spent on the distributing system, or 80 per cent. more than is allowed in the Tables.

Looking at these Tables as a whole it will be seen what an important part is played by interest and depreciation on the capital expenditure. If all undertakings were worked on their own bases throughout the country there would be nothing more to be said, but where as in so many cases we have portions of districts supplied by local authorities, the position becomes complicated. For instance, if local authorities borrow money at 3½ per cent. and their sinking fund is 3 per cent. and they do not otherwise allow for depreciation, this with the reduced Parliamentary expenses they will probably incur will enable the interest charges to be cut down below those adopted in the Table and a corresponding reduction of price to be made for the energy sold. No doubt when power supply in the industrial districts gets established on a firm basis and the outlook is secure, companies established for the purpose of giving such supplies will be able to obtain money at lower rates than those indicated, while local authorities having to spend more and more money if the power supply in their districts is developed will have difficulty in raising it so cheaply; but at present it must be acknowledged that the financial position has a strong tendency to lead to the undue development of small undertakings, while correspondingly hampering the laying out of the work on lines which are in themselves the most economical.

We will now pass on to the engineering aspects of our subject.

The Modern Electric Power Station.
Location of Stations.

When the source from which the electric energy is to be generated is coal, it is desirable that the station should be located in a position in which the best facilities exist for coal delivery, but in doing this it is to be remembered that delivery of coal by rail to a given point is usually cheaper than transmission of energy by cable in the United Kingdom, so that there is seldom a gain to be made by securing a shorter rail transit at the expense of correspondingly longer cable transmission. This is one reason why so far we have seen little of long distance transmission in this country. Again, when the power station is situated in a coalfield, the idea of locating the station at the pit's mouth is one which is not found of value in practice. Power stations only use one sort of coal, a cheap class of small size, and it is seldom that one colliery can produce all that is required of this particular kind, and if so the colliery owners will regulate their price by the cost of delivery of the same class of coal from other mines to the power station, and accordingly the station should be located in a position where it can easily command a supply from a number of competing collieries.

The next point to be considered, with the type of stations which are being erected now and which usually employ steam turbines, is the question of water facilities for condensation.

Condensing Water.

With marine engines the general rule was formerly that the condensers required about 35 times the amount of water to flow through them which was condensed from the steam used by the engines; with turbines, however, since higher vacua can advantageously be used demanding lower temperature cooling water, it is desirable to arrange for from 50 to 70 times the flow if possible, so that the question of water supply becomes of great importance especially if the station is of large size, and it may pay to go some distance from the centre of the district to be supplied to secure adequate water facilities. On the above basis a 10,000 kilowatt station will require about 1,000,000 gallons of water to pass through the condensers for each hour's work at full load. Not unfrequently in inland stations these facilities are impossible of attainment, and then recourse must be had to cooling towers, which are so arranged that the warm condensing water trickles down in tiny streams over wood slats arranged in tiers in a large casing forming a chimney, large volumes of air being drawn through this by natural or artificial draft. The evaporation ensuing rapidly cools the condensing water which by this means can be used over and over again, the loss by evaporation being about three-fourths of the weight of steam condensed. Cooling towers are also very valuable for partly dealing with the water when a certain amount of change can be arranged. The construction of these towers and of condensing apparatus has been greatly improved and cheapened during the last few years, so that the loss in efficiency by not having the large supply of water needed in the form of a river is not so great as it was even three or four years ago. It is also a point to be borne in mind that should gas-engines come to be employed in the future the need of such large water facilities will be diminished; thus, although water facilities still remain a very important item, too much should not be sacrificed for them. For instance, in the contests which have gone on during the last four years over the electric supply of London it has always been the writer's opinion that too much has been made of the importance of water facilities as such, especially having regard to probable improvements in generating electricity in the future.

The Departments of Power Stations.

The power station itself is naturally divided into four well marked divisions. First, the coal handling and sorting plant; next, the boilers or steam-raising division; then comes the steam utilization and electric generating division; and, lastly, we have the very important and somewhat complicated electric control department, comprising the switches, measuring, indicating and recording instruments with the means of control necessary for the proper working of the whole installation.

We will deal with each of these divisions briefly in the order mentioned, first with the coal. There is no division of central station work in which greater progress has been made than this during the last few years. In all well conducted large stations coal is now constantly tested for its calorific value, smoke, moisture, and amount of ash, and should be bought subject generally to these tests with fair variation allowances. There is a constantly growing tendency to look into these points more closely as they are found of importance in securing the

best and most constant results and in keeping a check on the stoking.

Coal and Coal Conveyors.

The treatment of coal has also of late years undergone much modification; nearly all coal now is screened at the collieries, the poorer qualities washed, and the whole graded into sizes. Formerly the general rule was that the larger the lumps of coal the higher its value, but now evenness of size is of the utmost importance, whilst dust is detrimental. The classes of coal most commonly used now in power houses vary in size from that of a pea to that of a walnut, and a good deal of larger coal at the collieries is now broken down from large lumps to these sizes, so great is the demand. Thus coal is dealt with as though it were a viscous liquid rather than a solid, and the methods of handling it are based on this assumption. On arrival at the power station it is either tipped out of the waggons into a hopper, or if delivered by boat is lifted into the hopper by grabs or other suitable means. In either case it is automatically weighed, usually by a self-registering arrangement which prints the weights. It is then carried by conveyors, usually consisting of shallow buckets arranged in a double chain, either to the reserve heap, or to bunkers situated over the boilers, which are usually of sufficient capacity for several days supply to the station; a point which must be watched being that the coal should not heat in these. Much ingenuity has been expended in working out the details of these lifting appliances and conveyors so that about three men can control the unloading and storing of 50 to 100 tons of coal per hour if necessary.

From the bunkers the coal descends to the boilers by shoots under control of the fireman, and it is usually again weighed here so that a record is kept of the amount of coal going to each boiler.

Boiler Water.

In ordinary private steam installations one of the chief difficulties nearly always arises from the water supply, owing to deposit in the boilers and the resulting loss of efficiency and cost of cleaning and repairs. In the modern central station these drawbacks have almost vanished with surface condensing, particularly if steam turbines are used, as then the condensed steam is returned to the boiler as clean distilled water and the loss can be kept well below 5 per cent. for each evaporation. The amount of fresh water to make up is, therefore, relatively small, and it usually pays to use the local water company's water for this; this water, moreover, is further treated for the expulsion of lime, and neutralisation of any alkali or acid. Methods of treating water have also been much improved of late, and in a large station the water will be tested at least every day to see that the treating process is fulfilling its work properly. This water after being treated is usually also passed through an economiser where it is heated above boiling point, which again helps to deposit any lime in a soft form easily dealt with before the water reaches the boiler. As a result of all these precautions, deposits in boilers such as were generally common have become things of the past, and boilers often now run for months without being opened up, and then are found to need scarcely anything doing inside. Thus the conditions under which steam is raised have been greatly altered, most of the old troubles which principally occupied engineers have disappeared, though with the higher standard of efficiency aimed at numerous other points now require careful attention which formerly were almost entirely neglected. It has often occurred to the lecturer that we may be now coming to a time when it would pay to use condensers for purifying the feed water as in marine work; namely, cascade condensers, which can now be obtained to distil as much as 50 lbs. of water per pound of coal, and thus ensure an absolutely pure water supply free from salts in solution which cannot be got rid of by treating, and which are apt to pit the boiler tubes.

Boiler Pumps.

A weak point in power station arrangements has always been the boiler pumps, which even with the best designs take an inordinate amount of steam for the work they do. Electrically driven pumps taking their supply from the station omnibus bars are in use to some extent, but it has been difficult to get anything so far which will conveniently and satisfactorily perform the very heavy duty expected from a boiler pump, which has to work against a constant head for the whole stroke, and has to do this over a very wide range of speeds. The new Rees Roturbo pump is now being coupled to an electric motor and applied to this work, and if it succeeds permanently it will have removed a source of undue loss. Although, however, boiler pumps may be inefficient apparatus in

power stations, they are still more so in private plants; and, when, as is frequently the case, cheap pumps are used and not well looked after, it is a common thing in such plants for the pumps to take over 100lbs. steam per horse-power hour, and in small installations they may even quite seriously reduce the overall efficiency of the plant. Theoretically, each pump should take about three per cent. of the power in the steam generated; but twice this figure would be a moderate amount to allow in most central stations—six per cent. Neglect of the pumps may greatly increase even these allowances.

THE MINING INDUSTRIES OF BOLIVIA.

Bolivian purchases of mining machinery depend on the development of the tin, silver, copper, and gold mines. The introduction of modern machinery is likely to be the result of the railway building which is now going on, since this will reduce the expenses of transportation, and render accessible regions that heretofore have worked the mines after the old methods and with limited means, on account of the very heavy charges incurred in carrying the products of the mines. According to the United States Special Agent in Bolivia, the tin mines are likely to furnish the best market. The Bolivian production in 1907 was approximately 16,000 tons of pure tin, slightly less than for the previous year. Substantially all the shipments are in the form of barilla or concentrates: These are calculated on the basis of an average of 60 per cent. of pure metal in the ton of concentrates, and the Government export tax is levied on that basis. The average price for 1907 was £97 for the concentrates, and £173 for the metal. When the price rose to £200 per ton, all the Bolivian mines were active, and many new ones were opened up, in the expectation that the boom would continue. The drop in the price of the metal naturally caused most of the new enterprises to be suspended, while a large number of the small mines also shut down temporarily. These were mines employing 80 to 100 workmen, and possessing only the crudest facilities. The majority of the larger mines were able to keep going. When it is recalled that in 1900 Bolivia was producing only 6,000 tons of tin as against 16,000 in 1907, some idea may be obtained of the future development and the market for machinery that will be opened up. The bulk of the output is in the departments of Oruro and Potosi, all of which is carried on the railway to Autofogasta on the coast. The Huayani-Potosi, and the Milluni and other mines in the La Paz district have about 8 per cent. of the production, which is shipped by Lake Titicaca and Mollendo. A few of the richest mines, notably those in the neighbourhood of Oruro, where the tin exists in combination with silver, employ a crude smelting process and are able to ship the tin in bars, but generally the very high cost of fuel and other conditions make the shipment of the concentrates cheaper than the smelting of the ore, so that manufacturers can depend on the demand in the future being along the same lines as at present. Up to this time most of the stamps and tables for the concentrators and other machinery have been imported from Europe, one reason for this being perhaps that until quite recently there have been no American interests in Bolivia. The ownership of the tin mines is English, Chilean, and German, and the purchases have been largely made through London and Hamburg. Germany has sold large quantities of mining machinery because it had control of Bolivian commerce in all lines. These sales were not due to superior quality or to cheapness. It is almost the universal testimony that German installations for the tin mines have been unsatisfactory. It has been stated by a large mine owner that he would like to throw out the German installation entirely, but that neither he nor other mine owners could afford to "scrap" their machinery by wholesale, and they would have to continue working along, and gradually replace the German machines with those from America, as their initial purchases in the United States had been satisfactory. Preference, however, is shown for the English make, as being more solid. There is, it is said, the possibility of a severe competition between England, the United States, and Germany, the German agents promising to supply better material, such as that from the Krupp works at Essen. The works at Creusot, France, also have local representatives, but they are not represented by actual installations in many of the mines. In the laboratories for metallurgical work the chemists and mining engineers give the preference to France, one reason being, it is stated, that the French packing is almost perfect. Laboratory supplies from the United States usually come broken in pieces. During the last two years various mining experts from the United States have made investigations of the Bolivian tin deposits, and of the mines in operation. It is well understood that the tin plate interests of Pittsburg and elsewhere would like to secure control of the output of some of the leading mines, but nothing seems to have been accomplished in this direction yet. Other American interests, some of them with rather limited capital, have undertaken the development of tin mines on their own account. The American capitalists, who are building the Bolivian railways, have also mining concessions, but it is not understood to be their intention to have the railway company engage in tin mining, or other mining. It is more than likely that some of them will invest in the mining business as individuals, while the policy of the railway company will be also to encourage other companies or individuals to engage in mining in order to supply the railway with articles for transport. Out of this policy there is likely to grow a number of

American mining interests, which will buy machinery in the United States, provided the objections as to bad packing are removed. It may be taken as certain, says the United States Special Agent, that Bolivian tin mines, during the next few years, are going to be developed on a scale which will call for large quantities of machinery. The increase in silver mining is dependent on the railway line from Oruro to Potosi, which now seems assured, since the American and the English interests are harmonising their differences. Potosi is the most extensive silver mining region of Bolivia, but the lack of transportation facilities has made it impossible to introduce new machinery, and without this, and the application of modern processes, it has been shown that the Potosi mines, with some exceptions, cannot be worked so satisfactorily as is desired. The Huanchaca mines, near Uyuni, which, for many years, were among the most profitable in South America, are in full operation, and are supplied with modern machinery. The output of the Corocoro copper mines is not expected to be seriously diminished on account of the fall in the price of that metal, since most of those in operation were able to continue in spite of the depression. New development, however, was checked. The Corocoro fields are agreed by experts to be very rich, but their development on a large scale has not been attempted heretofore, because the efforts to combine them have failed. Promoters from the United States, at various times, have obtained options on these mines, but have not secured the capital necessary to take up the options. The capitalists in the United States, whom they have approached, have invariably declared the price too high. It is possible, however, that in time the negotiations will succeed, and the exploitation of the Corocoro copper will be undertaken on a large scale, ensuring heavy purchases of machinery. At present the disposition appears to be to await the building of the railway line from Arica, which will ensure a short railway route to the coast, and effect an important saving in the cost of transport. There does not appear to be much prospect of immediate sales of dredging machinery for Bolivian gold mines. Several years ago dredges were installed in the San Juan river-bed in the south. The cost of the installation was very high, since the machinery had to be carried by mules for two hundred miles over difficult mountain passes. Now the railway, which extends from Buenos Aires to the Bolivian border, removes this difficulty, but the dredging itself has not been successful enough to encourage further importations of machinery. In the Tipuani river, in northern Bolivia, gold is abundant, but the transportation of dredging machinery is entirely impracticable, and the Tipuani is likely to be left to the primitive methods of placer mining. A point which should have attention in connection with mining machinery is the large quantity of explosives consumed in Bolivia. These are procured almost entirely from Europe, Germany having the lead. It is said that the bad name given to American manufacturers of explosives by the action of one company, which some years ago dumped a lot of inferior dynamite on the South American market, has not yet been overcome. In conclusion, the Special Agent says that Bolivian mining resources, both from the point of view of the manufacturers of machinery and from that of capitalists, are worthy of the most careful investigation, for the country is one of the world's greatest mineral regions. Until railway communication could be obtained, many of the districts, notwithstanding the richness of their deposits, could not be expected to command capital, because of the prohibitive cost of transportation, both for machinery and for ores. That difficulty is now being removed, and with the extension of the railway system a continuous mining development may be looked for.

THE UTILISATION OF EUCALYPTUS LEAVES.

There are many places in Australia where eucalyptus oil is distiilled for medicinal purposes, and there is said to be an establishment in New South Wales where acetic acid is an important by-product in the distillation of the oil. It is, however, at Fort Esperance—about fifty miles distant by water from Hobart—that the eucalyptus oil itself is considered merely a by-product in the preparation of the more valuable extract for use in preventing deterioration of boilers. This extract has the appearance and consistency of tar when prepared for export to England. It is shipped with no more liquid in it than is necessary to prevent caking in the casks *en route*, it being thinned, however, on its arrival. The extract is said to diffuse itself through the water of boilers and cleanse them of any acid, greasy or saline matter, forming with such deleterious ingredients a harmless sediment which sinks to the bottom, and it prevents any formation of crust round the water-line. The American Consul at Hobart says that four tons of eucalyptus leaves will produce one ton of the extract for boilers, and about seventy or eighty pounds of eucalyptus oil. Twigs of the leaves are taken off the trees irrespective of the age or height of the tree, except that old trees are not preferred owing to the great preponderance of woody matter. They are placed in large bags, and, by an iron hook arrangement, are carried down the hill-side along wires specially strung for their easy transportation to the mill. The leaves are for the most part about ten inches long, and from an inch to an inch and a half wide. The leaves mostly used at the establishment referred to above are taken from an underbrush of trees in "bush" destroyed by fire about two years ago. The same trees may be considered good for another crop of satisfactory leaves in about three years after the first leaves have gone to the mill. The leaves are placed in a large cauldron, called a digester, and steam is applied for four hours. During this steaming the acetic acid in the leaves passes out as

vapour, the eucalyptus oil is carried by the steam to the condenser, the waste water being separated by the use of a syphon. The residuum in the digester is then subjected to steam pressure, by means of which the valuable extract is obtained, being first, however, boiled down to the consistency of tar. The woody matter which is left in the digester after the oil and extract have been taken out is then removed, and burned as refuse. In order to prevent the digesters being eaten by the action of the acetic acid in the leaves, they are painted with the extract before the leaves are put in and the steam applied. Some experiments have recently been made at Port Esperance to ascertain if varieties of eucalyptus leaves, other than the blue gums, could be used for the production of both boiler extract and eucalyptus oil, and as a result it appears that practically every variety of eucalyptus leaf will furnish the boiler extract, but that the best quality of eucalyptus oil by-product is obtained from the blue gum. The stringy bark contains more of the extract, but less of the oil than the blue gum. The local consumption of eucalyptus oil for medicinal purposes is very large. There are other uses to which, it is said, eucalyptus can be put, although there has, as yet, been no practical demonstration of such uses in Tasmania. An illuminant, known as "gum gas," can be produced from the leaves, and is said to give a bright light. An Australian authority has estimated that 10,000 feet of gas can be obtained from a ton of leaves. The eucalyptus bark is said to contain a fibre suitable for paper, and eucalyptus woods are considered valuable for many purposes.

HOME INDUSTRIES.

The Coal Trade.—Although the labour troubles in South Wales have been settled for the time being, the dispute between masters and men in Scotland has become more acute. A week ago the Scottish coal masters decided to post notices of a reduction of wages on the 26th inst. This decision followed on an abortive conference. The proposed reduction of wages is 12½ per cent. on the standard and would amount to about 6d. per day per man. It is induced by the Eight Hours' Act, which reduces the number of hours the men are at work. The employers insist that if the hours are to be shorter the pay must be less. On the other hand the men look upon the Act as one intended to benefit them, whereas if their wages are to be reduced at the same time that the hours of labour are shortened they will consider it as of very doubtful advantage to themselves. The Scottish trade holidays are now in full swing, and iron furnaces have been damped accordingly. It may be hoped that some arrangement will be arrived at even now, and it must be remembered that the men are financially in a very weak position. The numbers affected by the lock-out would be something like 100,000, 80,000 miners and 20,000 pit-workers, but the men's accumulated funds only amount to £70,000, which would mean bankruptcy for their union in a fortnight unless the Welsh and English miners made a substantial levy. The danger of serious complications lies here. It is not at all unlikely that the English and Welsh miners will decide to range themselves along side the Scotch miners, in which case the whole situation will be changed.

Pit Lads.—In Staffordshire 7,000 pit boys are on strike, and there has been rather serious rioting. All the important pits in North Staffordshire are now idle, and an industry which employs 25,000 men, and yields a product of some 7,000,000 tons of coal annually, is paralysed. As a consequence of the dispute some of the forges and furnaces in the steel industry in the district have already been damped down, owing partly to the shortage of coal, and partly to the fear that damage may be done to the plant. Here again the trade disturbance is due to the Miners' Eight Hours Act. The ostensible cause of the trouble is the question of a stoppage for a meal, or for "snapping," as it is called. Immediately upon the Act coming into force (July 1st) difficulties arose. The miners contend that under it, as interpreted by the masters, their conditions of work have become worse. They say it entails longer hours instead of shorter. Before the Act came into force the men in this district did not put in a full eight hours of actual work in the pit. The masters now seek to enforce a full eight hours of work. This, with the time spent in "winding" and in getting to work, entails sometimes, the men say, as much as ten hours from bank to bank. The masters, too, require a full eight hours without "snapping" time. Previously the men had half an hour allowed them for eating, but the dispute as between masters and men on this particular point has been settled by compromise, the masters agreeing to allow a quarter of an hour instead of half an hour as aforetime. It is against this agreement that the lads have risen, since under it many of them, as they say, get no "snapping" time at all. They must keep on working. The agreement between masters and men stipulates that the men must take their snapping time not altogether as they used to do (the pit being "stopped" for the purpose) but in two separate lots. The long wall system is generally used in North Staffordshire, and the arrangement was that while the men on the one "side" had their "snapping" the men on the other "side" should be at work, the object being to prevent any stopping of the pit during the eight hours. Unfortunately this arrangement means that the lads working in the roads between the men have to keep on the eight hours without a break. Hence the strike.

The Co-Partnery Mining Project.—Many will regret the failure of Sir Christopher Furness's co-partnery project referred to in these Notes some weeks ago. It has failed because the men have rejected it.

Sir Christopher Furness, in his reply to the leaders of the Wingate Grange Colliery workmen, says that "he is afraid that the resolution of advice to the men was influenced by bias, personal as well as political, affecting the county, and in fact the country at large, rather then by reasons purely economic and applying to the employees at Wingate alone." However that may be, the men seem to have been influenced by the fear that the proposed colliery council would become a "hot bed of spies," and also that only the first-class workmen would be employed. There does not seem to have been any attempt on the part of the representatives of the men to smooth over difficulties by consultation with Sir Christopher Furness, but he is willing to revive the project if, and when, the men are prepared to consider it more favourably.

Gas Engines for Steel Works.—The *Manchester Guardian* gives some particulars as to the equipment of two important steel works—those of the Barrow Hematite Steel Company, Limited, and the Frodingham Iron and Steel Company—with blast furnace gas-engine plant of German design and manufacture. In the former case, it is claimed that a saving of £1,000 a week has been effected by the German gas engines put in to utilise the waste gases from the furnaces. At the Staffordshire Steel Works, Bilston, a new electrical and power plant has been installed by British engineers, and in reply to some disparaging comparison made between this and the German plants, Sir Alfred Hickman has written a letter to the *Iron and Steel Times*, in which he says:—"It is true that some difficulties, not unusual in a new departure, have been experienced, but if I am correctly informed, they are far less than have attended a somewhat similar installation by a German firm at works in the North, the engineering staff of which have honoured me by repeated visits in order to obtain information and assistance. The arrangements here are not yet perfected, but there has been no shirking of responsibility on the part of the contractors, and I have every confidence that in the end the work will be fully equal, if not superior, to anything the Germans have done, and the cost will certainly not be greater than they would have charged."

Hop Substitutes.—It is not, perhaps, surprising that the Government Bill to prohibit the use of hop substitutes in brewing, and the importation of hops except in bags properly marked, should be described by political opponents as protection, "unadulterated, naked Protection," as Lord Courtenay put it in the debate in the House of Lords upon the second reading. The object of the Bill is to prohibit the use of preservatives when the necessary preservation can be obtained by the use of hops alone. This is not an absolute prohibition of preservatives, since to do away with them altogether might mean the destruction of a great trade in a certain class of beer intended for export, but if the Bill becomes law it will no longer be possible to use them in beers intended for home consumption. As to marking, the intention is to place the foreign and home hop growers on an equal footing. Lord Carrington described the Bill as "an honest attempt to assist a hard-working and honourable class of people who have been passing through a time of much difficulty." The object is excellent, but it is to be feared that even if the Bill becomes law it will not arrest the shrinkage in the area of hop cultivation which has been going on for many years past, and of late at a much accelerated pace.

American Wheat Prospects.—Although our imports of wheat from America are comparatively much less important than they were ten or fifteen years ago, they are still a very important factor in the movement of prices, and it is therefore satisfactory to find that on the whole the prospects of the present American crops are encouraging. According to the Government crop report the condition of winter wheat on July 1 was 82·4, in comparison with 80·6 on the corresponding date of last year, and a 10-year average of 79·6. Unfortunately the acreage under cultivation is 8·1 per cent. less than the wheat area harvested last year, the acreage this year being 27,871,000. It is estimated that the winter wheat crop will be about 410,000,000 bushels, as against 480,000,000 bushels in 1908, and 409,000,000 in 1907. But the spring wheat crop promises to more than adjust the balance. The acrerage under spring wheat is nearly 7 per cent. more than last year, and the condition of the crop on July 1 was 92·7 as against 89·4 in 1908, and a 10-year average of 87. The yield is expected to be about 254,000,000 bushels, in comparison with a crop last year of 226,000,000 bushels. Taking spring and winter wheat together the present estimate is about 663,000,000 bushels this year, which does not differ materially from that of last year. This is better than was anticipated at one time, but bearing in mind the constant growth of the American home demand it is obvious that the United States will not do much this year towards bringing down prices to meet the level of the last 10-year average.

Trade Unions and Labour Exchanges.—Representatives of the Trade Unions met the President of the Board of Trade last Friday to discuss the subject of labour exchanges. They suggested regulations which would bring into the committees in whose hands the local control of the exchanges will be representatives of employers and workmen in equal proportions. An important condition asked for was that exchanges shall not be used for the purpose of facilitating attempts by employers to break down a strike or carry on a lock-out, and the delegates wished to be assured that they would not aid in reducing the standard of wages or other labour conditions in the localities in which they operate. On many points the President of the Board of Trade was in agreement with the deputation, and promised to incorporate

their proposals in the regulations when they are made. None of the regulations have yet been framed, the Government wishing to have the views of all interested before framing them. It is expected that the regulations will be issued in the autumn, although it is not likely that any new exchanges will actually be at work before the new year.

CORRESPONDENCE.

CANADA AS A FIELD FOR BRITISH INVESTMENT AND SETTLEMENT.

Mr. J. Obed Smith, in his paper on Canada, published in your *Journal* of June 11, gives as a quotation from Chisholm's "Commercial Geography" a sentence that he seems to have read rather hurriedly. He says, "Professor Chisholm, in the third edition of 'Commercial Geography,' says:—'If British commerce has in recent years advanced with less strides than that of some other countries, geographical ignorance on the part of merchants and business men can be set down as one of the principal causes.'" The sentence, which occurs in the preface to the first edition of the "Commercial Geography," and is reprinted in the third edition, reads as follows:—"From my inquiries on the subject of commercial geography I certainly have not derived the impression that, if British commerce has in recent years advanced with less rapid strides than that of some other countries, geographical ignorance on the part of the British merchant can be set down as one of the principal causes."

A slip of this kind may be of little consequence, but, thinking that you, in justice to both Mr. Chisholm and the British merchant, might wish to correct it, I am taking the liberty of drawing your attention to it. ROBERT BAPTIE.

Seattle, Washington, U.S.A.,
June 29, 1909.

I have perused with much interest the extremely able paper read at a recent meeting of your Society by Mr. Obed Smith. There were two matters, however, which were not emphasised, and which I venture to suggest should receive consideration.

The first is the large field for investment in the debentures and shares of some of the smaller companies which present absolute security and offer a profitable return. I have come across a number of manufacturing concerns which are doing a good business, but which, if they had a little more capital, could double or treble their present turnover. This is especially so in Ontario, which is the manufacturing province of the Dominion. Mr. Smith referred naturally to the more important avenues for investment, but these require considerable capital, and the smaller capitalist and investor at home may not feel he can join in these large ventures, whereas there are numerous opportunities for the investment of sums of £500 and upwards in good, sound companies where substantial dividends can be earned. Further, in the case of a young man desiring to engage in commercial life here, if he can bring with him say £1,000, which can be invested in a good going concern, he can very shortly step into a position which he would not reach otherwise in connection with that business, provided, of course, he possesses the ability.

The second point is that if British capital is to find its way here for these smaller businesses, some one on this side should be employed, first to investigate the business and go over its books, then report to the investor at home, and afterwards represent such investor on the Board of the company. I could put my hand on a number of excellent businesses needing capital, where such an arrangement could be offered, and doubtless there are many others in a similar position to myself. ERNEST H. SCAMMELL.

40, Lombard-street, Toronto.

OBITUARY.

THE MARQUIS OF RIPON, K.G., G.C.S.I., C.I.E., D.C.L., F.R.S.—The Marquis of Ripon, who died at Studley Royal on the 9th inst., was one of the oldest members of the Society, which he joined in the year 1856. He never took any active part in the Society's work—on one occasion he presided at a meeting of the Indian Section in 1890, when Sir Theodore Hope read a paper on Indian Railways—but he supported the Society liberally, as for over 50 years he paid a subscription of Five Guineas per annum instead of the ordinary subscription of £2 2s.

Lord Ripon was a son of Viscount Goderich, who held office for a short time as Prime Minister, and became Earl of Ripon in 1833. He was born in 1827 and succeeded his father in 1859. After a short diplomatic experience he became, in 1853, a member of the House of Commons. Soon after his removal to the Upper House in succession to his father, he took office as Under-Secretary for War, and this was the first of numerous posts held by him in successive Liberal Governments. He was created Marquis of Ripon in 1871. In 1874 he became a Roman Catholic, and this, according to the obituary notice in *The Times*, involved his withdrawal from public life for several years. In 1880 he became Viceroy of India and held the office till 1884. He again held cabinet office after his return from India, his last post being that of Lord Privy Seal, in which office he acted as the leader of the Liberal party in the Upper House. In 1908 he resigned, nominally on the plea of failing health, but really it is said in consequence of the Government's interference with a proposed Catholic procession in Westminster.

NOTES ON BOOKS.

THE CAMPAIGN AGAINST MICROBES. By Étienne Burnet, M.D. Translated from the French by E. E. Austen. London: John Bale, Sons and Danielsson, Ltd.

This book is a translation of a number of articles by Dr. Burnet on cancer, tuberculosis, tetanus, sleeping sickness, enteritis, and smallpox. In a non-medical journal it will not be expected that any opinion should be given upon the views expressed in such a book, or even of the correctness of the statements or opinions. But it may at all events be said that a very clear popular account is given of the action of microbes in producing the various diseases dealt with, and in the treatment suggested for their alleviation. The subject is by no means exhausted, as, though the title is somewhat comprehensive, the subject-matter does not extend beyond the special diseases mentioned. The researches detailed appear to be mainly the work of others than the writer, for instance, the chapter on enteritis is mainly an account of Metchnikoff's work, which has been already introduced to non-medical readers by Dr. Chalmers Mitchell's translations of his well-known works, while the chapter on variola and vaccinia is a very interesting account of Jenner's work, and of the practice of inoculation which preceded Jenner's researches.

RELICS OF THE HONOURABLE EAST INDIA COMPANY. London: Bernard Quaritch. 1909.

In the year 1890 a report by Sir George Birdwood on the miscellaneous old records at the India Office was published by that office, and in the same year a paper was read before the Society of Arts on the subject by the late Mr. F. C. Danvers, who was at that time Registrar and Superintendent of Records at the India Office. The interest aroused by Mr. Danvers' paper induced Mr. Griggs to publish in his *Journal of Indian Art* some photographic reproductions of the more important charters and despatches of the Company. These pictures have now been reproduced in a sumptuous volume under the above title, and the reproductions have had the advantage of descriptions by Sir George Birdwood and Mr. William Foster, together with an introduction by Sir George Birdwood.

The reproductions, a number of which are in colour, include the arms of the first Company, several of the charters, warrants, and patents issued to the Company, and various other documents of great interest. There are also pictures of the various buildings occupied by the Company at different times, all of which were known in succession as "The East India House." Then there are some photographs of the interior and exterior of the India Office, and various other pictures of objects of interest in the history of the Company.

Sir George Birdwood's introduction gives a brief record of the foundation and early history of the Company, or rather companies, since the one first incorporated by Queen Elizabeth in 1600, and known as the Old Company, changed its character and status by the amalgamation with it of several other companies subsequently incorporated, so that the body known to us as the Honourable East India Company, which lasted down to 1858, may be said to date from a charter of Queen Anne of 1709. The letter-press which accompanies the reproductions is certainly not less interesting than the reproductions themselves, and the whole volume is full of information relating not only to the East India Company, but also to what Sir George Birdwood called in his Report of twenty years ago, "the modern quest and invention of the Indies."

It may be worth while to point out a trifling mistake in one place. George Lambert, the painter of the pictures now in the Military Committee Room at the India Office, was never a President of the Society of Arts. The institution with which he was associated was one of the two Societies of Artists, which grew out of the "Exhibition of Polite Arts" held in 1760 by the Society of Arts, and the rivalry between which led eventually to the foundation of the Royal Academy in 1768.

GENERAL NOTES.

THE ZIMBABWE RUINS.—Mr. Richard N. Hall, who gave the Society a paper on the Zimbabwe (Rhodesia) ruins in 1905, is about to publish a book on "Pre-Historic Rhodesia." The work is a reply to the conclusions of Dr. Randall MacIver as to the origin and age of the wonderful stone buildings and gold mines scattered over Rhodesia and South-Eastern Africa. Before the meeting of the British Association in South Africa in 1905, Professor Randall MacIver made an examination of Zimbabwe, and during his researches and excavations discovered specimens of Nankin china under some of the walls supposed to be ancient. This fact, and other indications, led him to adopt the conclusion that the buildings were not the work of a non-African, possibly Semitic, race of invaders and gold-seekers at a period of (say) 2,000 years ago, but were an independent development of indigenous Bantu civilisation and perhaps contemporaneous with the coming of the Islamic Arabs and the Portuguese (from A.D. 1200 to 1600). Mr. Hall has since re-examined the Zimbabwe ruins and made other researches in South Africa, and the results of these efforts is the forthcoming volume. Mr. Fisher Unwin is the publisher.

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FRIDAY, JULY 23, 1909.

NOTICES.

CHAIRMANSHIP OF COUNCIL.

On Monday, 19th inst., at their first meeting after the annual election, the Council re-elected Sir William White, K.C.B., F.R.S., LL.D., D.Sc., as Chairman for the ensuing year.

EXAMINATIONS.

The results of the Intermediate Examinations (Stage II.) have been published, and copies for distribution to Candidates have been sent to all Centres. The results of the Elementary Examinations (Stage I.) will be published about the middle of August. The results of the Advanced Examinations (Stage III.) were published on the 17th June.

The Council of the Society have had for some time under consideration a suggestion emanating from some of the local Committees that longer time should be allotted to the examinations than is now the case, so that greater facilities might be afforded to candidates wishing to take up several subjects in the same year.

Realising that this was a matter entirely for the convenience of the Local Committees, they caused a circular to be issued to all the Committees, asking for an expression of opinion. Replies were received from 201 out of the 392 Committees to whom the circular was sent, and the Examinations Committee, after an examination of the replies, recommended to the Council that the result of the inquiry did not appear to justify any alteration in the existing system.

This recommendation has been approved by the Council, who also approved a recommendation by the Committee that the rule requiring two Superintendents to be present at all examinations should be modified, and that in future the attendance of a single Superintendent should be considered sufficient when the number of candidates did not exceed ten.

The following is the Time Table for 1910:—

	Monday, April 11. (7—10 p.m.)	Tuesday, April 12. (7—10 p.m.)	Wednesday, April 13. (7—10 p.m.)	Thursday, April 14. (7—10 p.m.)	Friday, April 15. (7—10 p.m.)
Advanced Stage.	Book-keeping. Précis-writing. Economics. Danish and Norwegian.	Arithmetic. Commercial Law. German. Italian. Spanish.	French. Commercial History and Geography. Typewriting (7.30 to 10 p.m.).	Accounting and Banking. Shorthand (140 and 120 words per minute) (7.15 to 10 p.m.).	Portuguese. English. Russian. Swedish. Chinese. Japanese. Hindustani.
Intermediate Stage.	Typewriting (7.30 to 10 p.m.). French. Danish and Norwegian. Commercial History and Geography.	Book-keeping. Précis-writing.	English. Economics. Spanish.	Arithmetic. German. Portuguese. Italian. Russian. Chinese. Japanese. Hindustani.	Swedish. Shorthand (100 and 80 words per minute) (7.15 to 10 p.m.).
Elementary Stage.	Handwriting and Correspondence. French.	Commercial Geography. Typewriting (7.30 to 10 p.m.).	Book-keeping Spanish.	Shorthand (50 words per minute (7.15 to 10 p.m.).	German. Italian. Arithmetic.
Music.		Harmony.	Rudiments of Music (7 to 9 p.m.).		

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE PUBLIC SUPPLY OF ELECTRIC POWER.

By G. L. Addenbrooke, M.I.E.E.

PART III.*

Boilers.

We now come to the boilers. This is so large a subject that a whole course of lectures would not deal adequately with it. In the first place, water-tube boilers have become almost stereotyped as steam generators in power stations. The old doubt as to their ability to keep steam regularly has been removed by the almost universal adoption of chain grate, and overfeed, underfeed, and other forms of mechanical stoker, which enable a constant fire to be maintained. With mechanical stoking it has been possible to use larger and deeper grates than when hand-firing was employed, and this has enabled much larger boilers to be constructed than was formerly possible. A common size of water-tube boiler now is one evaporating about 16,000 lbs. of water per hour, and for large stations a standard size is made by several makers which evaporates 32,000 lbs. of water per hour, and even these figures are being exceeded. This is compared with an evaporation of 6,000 to 8,000 lbs. of water per hour, which is the usual evaporating power of the large size of Lancashire cylindrical boiler.

Boiler Arrangement.

An important point in central station design is the arrangement of the boilers. In small and moderate sized stations it is usual to place them in a parallel row with the engine room. For large stations the row becomes a double one, with the firing fronts of the boilers facing each other, leaving room for the economiser behind. For very large stations in towns it has been the practice for some time to place the boilers in two or more double tiers, though this can only be recommended when there is no other alternative. In similar stations when land is cheaper practice is now favouring the placing of the boilers at right angles to the engine or turbine room in double rows backing each other. This really changes the boiler room from a single unit into separate units for each turbine, requiring also a correspondingly increased number of chimneys. It has the advantage from the point of safety of breaking up the boiler room, but reduces its convenience and flexibility, and also somewhat increases the cost as well as that of the coal-conveying and storing arrangements.

The steam pressure most usually adopted now is 160 to 200 lbs. per square inch. With turbines the advantages of going higher are less than with steam engines, and the value of a good vacuum is greater, or rather a good vacuum is more easily made use of in the turbine than in the steam engine. Turbines also lend themselves very readily to the use of superheat. It is now the usual practice to superheat 150°, which appears to be about the desirable limit for the Parsons type of turbine. In the impulse turbine, when the clearances are greater, superheating has, however, been carried as far as 300° Fahr. with good results, and it is probable that in the future there will be an increase in this direction.

Superheating.

This superheating is usually obtained by fitting the boilers with a superheater placed just under the steam drums, and forming an integral part of the boiler. This is admittedly a compromise. An independently fired superheater allows better control of the superheat, and permits superheating to be carried further, but with coal firing it is troublesome and not always economical when the load is a varied one and there is a good deal of difficulty in finding a convenient place for it in the station. If producer gas were available in a station an independently fired superheater would have many advantages, and it might even be worth taking the steam in stages through the turbines, superheating between, or subdividing the turbine itself into two stages. In dealing with superheat, however, it is necessary to be careful to ascertain by how much the percentage gain exceeds the amount of coal used to obtain it, as it is easy to get a higher efficiency but at an increased consumption of coal which more than balances the gain. A good deal of care has also to be used to keep the superheat even and prevent excessive rises of the temperature as load decreases.

* The Course consisted of three lectures, delivered on January 18 and 25, and February 1. In re-arranging the material for publication, the lecturer has preferred to divide it into four parts.

Stoking and Working.

The almost universal adoption of mechanical stoking in modern boilers for considerable output has already been alluded to, and also the automatic delivery of the coal to the stokers. By these means the usual manual labour of the stoker is reduced to occasional clinkering, clearing away ashes and a few other odd jobs about the boiler house, but it does not follow from this that his labour is lightened; what has been taken from his hands has been placed on his head. Besides the steam, water and superheat gauges and the boiler pumps, economiser and forced or induced draught appliances, he has to watch the rate of travel of his grate or rate of working of other forms of mechanical stoker, the thickness of his fire on the grate, the amount of draught and the getting rid of the ashes, and whether the coal is fully burned out before reaching the end of its travel. All these points make great differences in the efficiency of the plant.

A boiler worked at its best can under good working conditions, such as should be obtained in a power station, transfer about 80 per cent. of the heat in the coal to the water and steam in the boiler; of the balance rather more than 10 per cent. will be lost in gases going into the flue of which a part may be recovered in the economiser, and rather less than 10 per cent. will usually disappear in radiation, say 8 per cent. or 1-12th. Now it is important to observe that the lost 8 per cent. is a loss which only slightly decreases whatever the boiler is doing, if steam is kept up under pressure, consequently at half load this 8 per cent. becomes about 15 per cent. and at quarter load 30 per cent. of the total coal, until we gradually come down to the boiler standing banked, when 6 per cent. to 7 per cent. of the coal required at full load will be required merely for the purpose of keeping steam up to pressure.

This does not represent the whole loss of efficiency as boilers are worked at lighter loads, because at lower loads it is increasingly difficult to secure just the right proportion of air, and an increasingly large proportion of heat will be carried off in this way.

Notwithstanding these losses in working at low loads and in keeping the fires banked, it is as a rule, however, found that when a boiler has to be used for only a portion of the day, it is more economical in coal to bank it than to let it down entirely and to fire up again.

Radiation Losses and Losses by Excess Air.

To give an example, assume a boiler capable of evaporating 16,000 lbs. of water per hour, a common size in power stations, this will at full load evaporate and superheat about 8 lbs. of water, equivalent to about 8¾ lbs. of saturated steam. Owing to the above reasons, however, at half-load it will not evaporate more than 6½ lbs. of water, and at ¼ load about 4 lbs. of water per pound of coal, while if it is banked and doing nothing it will consume not less than 1 cwt. of coal per hour to keep up steam pressure. Now these radiation and other losses are to a considerable extent within the control of the stoker, particularly as regards the coal used in banking and in firing up, and it is obvious that the stoker who can avoid stoking up an extra boiler to carry his heavy load will be the better man.

The stoker has, moreover, great control over the draught and over the coal burnt. If he lets too little air through his grate he will not use the full evaporating power of the boiler; if he lets in too much by having too thin a fire the cooling may reduce the evaporation 10 per cent. to 15 per cent. or more. It is again quite possible to lose several per cent. of the combustible by letting it through the ends of the grate before it is completely burnt. It will therefore be seen that in boiler-houses, to secure the best results, particularly when the load varies considerably during the twenty-four hours, much intelligence is needed in managing the boilers, and it is quite easy with the same plant to get differences of coal consumption of 20 to 30 per cent., or even more, for the same amount of water evaporated.

CO_2 Recorders.

In order to guide the stoker it has lately become the practice to instal what are called CO_2 recorders in the flue from the boilers. This apparatus draws automatically a sample of the gases passing every quarter of an hour or so, and the gas being passed through a proper piece of apparatus the carbonic acid is absorbed, increasing its weight correspondingly, which weight is automatically recorded. Knowing the proper proportion, this at once shows if too much or too little air is being admitted to the grates. This is found to call the attention of the stokers to irregularities which they would not notice otherwise, and if intelligently used it considerably promotes efficient working. Some difficulty arises if the boilers become numerous, as a single

instrument gives only a general result, but nevertheless it is a very distinct gain in station practice.

Losses in Boilers.

For the reasons which have been mentioned it is clear that the coal used per pound of steam supplied to the engines or turbines will be considerably more than if the boilers could always be maintained at their best efficiency; thus in a lighting station it is quite common that the weight of coal used per annum is three times the amount which would be used if engines and boilers could always be worked to their best efficiency. In power stations the difference is less. In a 2,000 kilowatt station working with a 25% load factor the coal used will be about 1¾ times to twice that necessary if the boilers and the engines or turbines were used to the best advantage. As the size of the station increases and the load factor improves the proportion of these losses is somewhat reduced, which is one of the reasons for concentration.

In most stations economisers are used situated in a flue behind the boilers, or above them sometimes when space is limited. Unless coal is very cheap, the extra duty obtained is well worth the additional capital cost, particularly if the station has a considerable load, as we are assuming, since with them the hotter feed enables a heavier duty to be obtained from the boilers at full load. The gain to be obtained depends on the type of boiler used, the draught, conditions of working, &c., but may be taken as in the neighbourhood of 12 per cent. on an average.

The Draught.

The cost of constructing brick chimneys has greatly lessened during the last few years, and frequently iron chimneys are now substituted for brickwork; but, notwithstanding these economies, there is a strong tendency in large stations to adopt induced or forced draught, usually the former, by the aid of a fan fixed in the flue, near the base of the chimney. There is little doubt that as the loads in power stations get heavier more and more reliance will be placed on mechanical draught, and probably on the development of this, which is obtained by using the Eaves principle of heating the air before it reaches the coal by the help of the waste flue gases.

The use of economisers, forced or induced draught, and air heating are all important factors, but their relative value depends so much on the character of the load, the classes of coal used and its price, and the balance of extra capital cost of these refinements against the economies secured, that it is difficult to put the probable advantages into exact figures. Pre-heating the air is only employed to a small extent at present, it being rather difficult to adopt unless the boiler-house and flues have been designed, in the first place, for its use, but it is safe to say that its adoption will be much extended in the future. In cases where it has been used under suitable conditions a gain of something like 15 per cent. has been shown.

Looking at generating stations as a whole, we have now come to a time when the chief interest really centres round the boiler-house, and its working and economies. The steam taken by large turbines per kilowatt will be referred to later; but it can now be said that they have attained an efficiency such that for every 1 per cent. improvement it may be possible to make in their economy, it is probable that 3 per cent. or 4 per cent. can be attained by close attention to boiler-room problems, now that we are getting to know the working conditions more closely. It has not been worth doing this in lighting stations so far, because the load was on for such a short time, and the price which could be obtained for the unit was higher; but now that load factors up to 25 per cent. are common, and 30 per cent. to 40 per cent. not unusual, the matter is assuming a different aspect. An example of this will make the position clear.

Losses by Banking Fires and in Other Ways.

A first-class 2,000 kilowatt steam turbine will give a unit of electric energy, or a kilowatt hour at full load for about 17 lbs. of steam, including that taken by the auxiliaries, namely, air and circulating pumps. With a boiler in full operation, and provided with economiser and superheater, this amount of steam could be delivered to the turbine, including losses in the steam pipes, for about 2 to 2¼ lbs. of coal of ordinary quality. In practice, however, with a 25 per cent. load factor a station filled with such turbines would probably not be able to place energy at the switch-board under 3 to 3½ lbs. of coal per unit, and this would be very good practice. To this the distribution losses of between 15 per cent. to 20 per cent. would need to be added before the energy reaches the consumer, so that to supply 1 unit to a customer will in all need the expenditure of, at

least, 4 to 4½ lbs. of coal, whereas, if the load were continuous, 2½ lbs. would suffice. Intermediate load factors between 25 per cent. to 100 per cent. have correspondingly reduced rates of consumption of coal; but it may be approximately said that in practice the coal needed, owing to various losses and uses in the whole plant, and in keeping turbines running at low loads for an 8,000 to 10,000 kilowatt station is not far from double what it would be if the plant were working continuously at full load. For smaller powers this discrepancy is greater. Thus the writer calculates that for a station of 2,500 kilowatt capacity—a very common size—at 25 per cent. load factor, a unit cannot be delivered to a customer, including losses in transformation, for an expenditure of less than 5 lb. coal on an average, and this would be a very good result. With a load factor of 50 per cent. the coal expenditure would be reduced to 3½ lbs. per unit sold as compared with the 5 lbs. mentioned above. The importance of securing a good load factor is therefore readily seen, as well as of operating on a considerable scale.

Possible Improvements.

It may be asked what are the probable chances of improvement in these respects. Doubtless some improvements will be made in turbine efficiency. During the comparatively short time the turbine has been in use it has been greatly improved, and I think we may assume that turbines will be improved another 10 per cent. in efficiency; but having regard to the immense amount of work which has been done on the steam engine, and the fact that turbines now nearly equal steam engines in efficiency, apart from the gain in greater vacuum, it does not seem likely that very much more than this will be done. As has already been pointed out, a certain percentage gain in engine or turbine efficiency does not mean as things stand a corresponding percentage gain on the whole coal used.

The prospects of economies in the boiler house are however more hopeful. From experience derived from burning petroleum and natural gas in boilers, it is found that 10 per cent. to 20 per cent. higher efficiency may be attained than with coal, from the fact that it is so much easier to control the amount of air admitted and to keep it closely to the actual amount needed for the combustion of the fuel. If the action of a boiler working with a modern form of chain grate stoker is observed, it will be seen that most of the combustion takes place in the fire brick chamber in which the greater part of the chain grate is situated. If the fire is watched from the side it will be found that the heating of the boiler is mostly done by a flame of hot gases almost like a blow-pipe flame issuing from the arch over the grate, so that the boiler is really heated by gases formed in a crude way in the grate. The writer is coming to the opinion that it would probably pay to carry out this process further, and to separate the furnace altogether from the boiler, burning the coal in a producer, which is much better adapted for burning coal thoroughly and economically than a grate, and then utilising the hot gases in the boiler. In this way little of the heat of combustion would be lost and the regulation of the gas and air supply would be much more perfect, for less draught would be needed, and the boiler being simplified, it could be constructed much more air-tight, and also be effectively lagged, so that the present large loss by radiation and convection would be reduced, and as the supply of air could be almost entirely cut off, the losses in keeping steam at no load and low load would be greatly reduced. A producer can also be kept banked for a much smaller loss of coal than a boiler fire grate, and is also fired up more easily and quickly. There should then be some gain of efficiency at high loads and considerable economy in losses at low loads. The presence of gas would be also most useful in enabling separately fired superheaters to be used and effectively controlled. Such a change in practice must come slowly, but it does appear that in these and other ways considerable improvements in the amount of coal needed per unit for electric energy generated may be effected as compared with present practice in stations where the load is a varying one. There is also a possible alternative, which is to use ground coal with an air blast, as is successfully done now for firing rotary kilns for cement making, but that is less promising.

It may be said, if gas producers are to be introduced at all, why not at once use gas engines? This introduces a large problem which will be referred to later; in the meantime we will pass on from the generation of steam to its utilisation.

The Generating Plant.

Within the last three or four years it has become the almost universal custom wherever generating plants of more than 700 or 800

horse-power are required to instal steam turbines. For smaller sizes steam engines are still the more economical, but for larger the superior results to be obtained from condensing with the turbine make it slightly the more economical prime mover. The turbine, however, owes the favour in which it is now held to other advantages, viz., its relative cheapness in price, the small space it takes up, and its great fly-wheel effect, and generally its adaptability for the purpose for which it is required, in which it much exceeds the reciprocating engine.

Nothing that can be said under this heading is half so convincing as a visit to a large power station in which reciprocating engines have been installed, but in which recent extensions have been made with steam turbines. Besides the above advantages, the gain in simplicity and the ease with which the whole plant can be controlled and overlooked will appeal to the most non-technical observer.

To show the gain in cost, the London County Council some years since installed several large reciprocating engines in their tramway station, which cost, if the writer recollects rightly, between £12 and £13 per kilowatt including dynamos and conductors, while they have recently ordered extensions in the form of steam turbines to the amount of 10,000 kilowatts, for which the contract price was £4 per kilowatt. The turbines are probably rather more economical in steam consumption than the engines, they take less oil, and are less costly for repairs, besides being capable of carrying a considerably greater overload. The capital cost has, therefore, been reduced to one-third in the plant itself, besides the saving in floor space, buildings and foundations, which would probably make the total cost about a fourth of that for slow-speed reciprocating engines. The gain would not be so much as against high-speed engines, but in attempting to build high-speed engines of over 1,500 kilowatts we begin to get a number of undesirable features which have prevented them ever being popular.

In supplying electric energy publicly one of the most important considerations is the maintaining of an even electrical pressure in the distributing system under all circumstances. With alternating currents the rate at which all the motors turn is governed by the speed of the generating sets in the central station; and again, if light and power are to be supplied from the same mains, and if an even turning moment is to be kept up throughout the system, constancy of pressure is very important. Now, the essence of electric power supply necessitates the throwing on of large loads on the mains in starting machinery, in hoisting, and in other operations at short notice, and it is a primary necessity that the largest loads which may be thrown on and off the mains suddenly should not affect the rate of turning of the generators and the electric pressure in the mains appreciably. In both these respects the turbine is an excellent implement for the work it has to do. Owing to the high speed, the energy stored up in the turbine rotor and the rotating portion of the dynamo is usually about three times what it would be with a reciprocating engine and alternators. The following are the approximate speeds of turbines coupled to multiphase generators of different sizes:—

STEAM TURBINES.

Size in kilowatts.	Average revolutions per minute.
500 / 1,000	3,000
1,500 / 2,500	1,500
3,000 / 5,000	1,000
6,000	750

Again, in a turbine the governor acts immediately and on the whole turbine, while in a reciprocating engine there would be at least three cylinders on only the first of which the governor would act, the steam taking quite a considerable interval to pass through all of them. Again the large overload capacity has already been alluded to. It is found that between half load and 50 per cent. overload the consumption of steam in turbines does not vary per kilowatt output more than 10 per cent. Moreover, since the motion of the turbine is purely rotary and the speed is only very slightly raised at the heavier loads, the strains on the plant are very little increased by putting on it these heavier loads which would be fatal in the working of a steam engine. Moreover, by admitting steam past the first set of blades in a turbine without serious loss in economy the output may be even doubled for short intervals, and even for large ones if the dynamo is made large enough, as it is the heating of the dynamo which really determines the amount of overload and, to some extent the condenser. While the utilisation of these forms of carrying overload is not a thing to be made use of on every occasion, nevertheless it is exceedingly important in central power supply,

first as increasing the plant reserve in case of accident, and again often enabling a short peak to be met without incurring the loss of steam, &c., in starting up a second turbine only to shut it down again after a short interval. This ability to carry overloads has hardly yet been appreciated at its full value by engineers.

The consumption of steam by modern turbines per kilowatt hour output is approximately as follows:—

STEAM CONSUMPTION OF MODERN TURBINES.

Size K.W.S.	Half load lbs. per hour.	Full load lbs. per hour.
1,000	20·50	18·0
2,000	18·25	16·0
3,000	17·00	15·0
5,000	16·00	14·5
7,500	15·25	14·0

MEASURING STEAM CONSUMPTION.

It is interesting to note that what is called the Willans straight line law applies to turbines as well as steam engines. According to this law a certain amount of steam is necessary for turning the plant round at full speed without any external load, keeping it warmed up, &c.; the auxiliary plant, such as air and circulating pumps, also needs nearly a constant amount of power. The steam taken in addition to this for doing work is found to be almost the same number of pounds per horse-power whatever the load, if the vacuum and other conditions are kept the same. Knowing the no load losses, therefore, and the consumption at some given load or the consumption at two different given loads, we can find this extra number of pounds of steam per horse-power required for the external work, and therefore can predict what the steam consumption will be at all loads. It is, therefore, easy to estimate from the station records of the output of the station, what amount of steam has been used by the turbines, and it is a point about turbines that if they are kept in order the steam consumption in actual work remains the same indefinitely. Moreover, as all the steam is condensed and returned to the boilers, by measuring this we have another check; an apparatus for measuring this returned water by means of its rate of flow through a triangular opening in a tank has lately been put on the market, and is now frequently used. The measurement is continuous, and is recorded on paper on a revolving drum. In this way a complete balance-sheet for the working of the station can be kept, including the coal and water used, the steam passing through the turbine, the air flow up the shaft, and the electrical output from the station. This offers a means of checking the efficiency of the plant very completely, and of tracing the sources of loss. Until recently no steam plants have been run under such detailed supervision as is now possible in large stations, and this ability to give that close attention besides tending to great economy should enable improvements in detail to be effected.

THE STEAM TURBINE.

It had been my intention to deal more fully with the steam turbine, but as I see that following these lectures are to come a set from Mr. Johnson Stoney, who, as collaborator with Mr. Parsons, has an unique experience of turbine building, I feel that for me to say much more would be only going over the same ground twice.

I will, however, refer briefly to the forms of turbines. About the same time Parsons in England invented one form of turbine, and De Laval on the Continent another. In De Laval's type a very beautiful principle was boldly and scientifically made use of; the high pressure steam was expanded in an expanding nozzle of peculiar shape, and its velocity and pressure greatly reduced, while the total momentum in it remained the same; in this state the steam impinges on the turbine blades, acting by its weight so to speak and not by its pressure; good results were obtained, but the velocities required were so high that the mechanical construction became awkward, and though used to a certain extent this form of turbine never became popular. When, however, Parsons had developed his type of turbine with a number of rows of blades, the construction of larger sizes of the De Laval type was taken up by experimenters on the Continent, notably by Zoelly and Rateau, and in America by Curtis. By adopting De Laval's principle but breaking up the action into a certain number of stages, they reduced the velocity nearly to that required by Parsons, and produced a practical machine. Engineers in this country, however, were for a long time suspicious "that the power could not be taken out of the steam" in so few stages, and, at any rate, the Parsons type has enjoyed the greater vogue. Continued sucecsses, however, have been achieved with the Impulse type, and the two classes of machine are now openly competing on similar guarantees of steam

consumption. The advantages of the Impulse type are a more mechanical and robust consideration, a reduction in length, the practical abolition of the dummy balancing piston, and, lastly, the fact that considerable clearance can be left between the revolving and stationary parts without loss of efficiency.

This type is now being accepted by engineers for the largest contracts, and a great number have been installed in America and on the Continent.

If it proves as lasting as the Parsons type, and as free from cutting of the blades by high-pressure steam, a step forward in turbine construction will have been made of considerable importance. Probably the ultimate turbine will be a combination of the two principles.

From the turbine we will pass to its condenser. During the last three or four years, and since turbines came prominently forward, a great deal of work of a detailed character has been done on this class of plant, including the introduction of the Edwards Air Pump, improved types of circulating pump, better arrangement of the flow of the water through the condenser, the Parsons vacuum augmenter, and other details, which now make it possible to maintain a vacuum of 28½ inches under heavy loads.

The high speed of the turbine is in many respects in favour of the dynamo which is attached to it, and greatly reduces the amount of material necessary in construction as compared with low-speed machines, though a number of new mechanical problems are introduced owing to the centrifugal forces brought into play, and these need very special treatment. I will not go into detail further, as I understand that Mr. Johnston Stoney will treat these points in his lectures, except to notice a considerable improvement in the excitation of alternating generators by means of a magnetic shunt on the exciter, which, with alternating currents, automatically permits a much closer regulation than was previously possible, reducing the fall of pressure on inductive circuits of ordinary character between no load and full load from about 18 per cent. to about 6 per cent.

Multiphase alternators are made to run on turbines to give as high voltages as 11,000 to 12,000 and succeed well. It is, however, becoming doubtful whether in large installations, considering the cheap prices at which transformers can be obtained and their high efficiency, it is not better to operate the dynamos at lower voltage and transform up to the requisite pressure. This is especially the case if current at different pressures is sent out from the power house for feeding the near and more distant parts of the district.

Controlling Plant.

Under this heading comes what is generally known as the "switch-board." During the last few years the design and arrangement of this part of the station has been so developed and altered that switch-board is almost a misnomer.

In large stations now the operation of the switching appliances are often controlled from a central control board, which not only operates these but also the stop-valves of the turbines, which are in themselves operated by motors. The engineer in charge of the switching gallery can in this way start any turbine, put it into parallel with other plant running, and can connect or disconnect any feeders at will.

The central portion of the switching plant is the bus-bars, which are usually situated above the rest of the plant, and sometimes there are subsidiary bars, so that some portion of the station can be worked independently from the rest. Conductors from the alternators are connected with their switches and the necessary measuring instruments to these bars, and again from them the feeder circuits branch, passing on their way again through the requisite switches and measuring instruments.

Before the conductors from the alternators reach the bus-bars it is now becoming the practice in large stations to take off a connection for working the auxiliaries of each turbine so as to maintain each as an independent working unit.

The bus-bars themselves are usually bare copper conductors carried on insulators, in a separate fireproof longitudinal chamber, extending the whole length of the switch gear.

The working of all the controlling apparatus is based on the use of the oil immersed switch. The merit of oil for the purpose of breaking an arc was, I believe, first pointed out by Professor Hughes, and it may almost be said that station control at the pressure and for the powers which are now quite common is impracticable without this very simple expedient. These oil switches are operated by levers for moderate sizes, but the larger ones are usually actuated by special electro-magnets or small motors. In this case the switches are usually located away from the switch gallery, often in a gallery by them-

selves, each in its separate compartment, and all controlled by local electric circuits brought to some central point.

On account of the noise made by the turbines it is now frequently arranged that the switch operators for controlling the feeders shall be situated in a separate building. The attendant then can be placed in telephonic communication with the different sub-stations on the circuit, and can watch the indicating instruments on each feeder and manipulate them as desired.

To deal with the details of various switch boards and measuring instruments would need a set of lectures alone, such is the amount of thought and care which has been lavished on them, but the general construction and method of operation will be understood from the lantern slides shown.

The Distributing System.

Outside town areas power supply work has so far been carried out chiefly at pressures of from 6,000 to 12,000 volts; in the case of the power companies principally at the latter pressure, while the Newcastle company has now considerable lengths of cable working at 20,000 volts pressure. These pressures relate to the voltages between the phases of a three-phase supply, the system on which practically all modern public supply work on any scale has been carried out; this is proving itself the most economical and flexible of the different possible systems; in fact, several of the large towns having low pressure continuous current lighting plants have had to instal separate three-phase high pressure plant for supplying power.

For supply at these pressures cables insulated with paper saturated with rosin oil or some special kind of mineral oil are universally used, the paper being protected by a lead covering. It does not appear that anything is likely to arise to displace cables made in this way, since paper is cheap and the experience of its use which has been obtained during the last 16 or 18 years has been most satisfactory, both as to its durability and its power of withstanding continuously such pressures as have been mentioned.

The only drawbacks to the use of paper cables are that paper depends almost entirely for its insulating properties on the lead sheath remaining permanently intact and the joints being made carefully under proper conditions. A very slight amount of moisture which may make its way through a small puncture in the lead covering, or may get in through an unguarded and exposed end of cable, will usually be fatal to the insulation in a short time. The skill used in modern manufacture has, however, brought it about that there is very little risk of imperfection in the lead covering except from actual violence, and with careful jointing and laying, long lengths of these cables can be depended upon to work without fault from year's end to year's end, and any faults which do occur are nearly always located at the joints.

Such failures as do take place are usually due in the first place to resonance effects. This is a sudden rise of the electric pressure in a circuit, due to the release of stored up energy when a circuit having self-induction or capacity, as most alternating circuits have, is suddenly broken, as by opening a switch or breaking the circuit in some other way.

Methods of Laying Cables.

Cables are most cheaply laid by armouring them, covering with preservative compound, and laying them direct in the ground. In places where they may be disturbed it is usual to give them further protection by laying them solid in troughs filled with bitumen or pitch, or they are laid in earthenware, iron, or specially prepared conduits of fibre or cement. Much of the cable for power supply has been laid in conduits, mostly of earthenware, as two or more ducts can be laid at the same time, and this permits a second cable in case of extension to be easily and quickly added, or an existing cable to be drawn out for repairs or for replacement by a larger size.

Costs of Cables.

Approximate costs of such cables, including laying, were given in the first lecture, and are here repeated for reference:—

Section of cable. Square inch.	Approximate capacity in kilowatts up to	Cost per mile. £.	Cost per kilowatt capacity per mile. s. d.
·05	750	900	22 0
·10	1,500	1,200	16 0
·20	3,000	1,700	10 6

Probable Improvements in Cables.

The improvements likely to be achieved in this part of the work are the perfection of the insulating qualities of the paper covering of the conductors, by which either higher pressures may be safely employed with the same section of insulating material, or a reduction of thickness in the insulation would be permissible

for the same pressure, thus enabling a reduction to be made in the diameter of the expensive lead covering. Having regard to improvements in the manufacture, there is no doubt that the sections of paper at present in use are above what are really needed, these being governed rather by the thickness necessary to withstand occasional resonance effects than by the thickness necessary to withstand permanently the ordinary working pressure.

Resonance effects have already been alluded to. There is no subject which is in need of further investigation than this at present. The theory is clear, but the effects are difficult to follow in complicated circuits. The lecturer is, however, strongly of opinion that further careful study will result in these effects being reduced without undue expense until they are almost negligible, and this will enable considerable economies to be effected in the cost of cables, as it will permit the margin of safety now necessary to be considerably reduced.

Resonance effects in cables are guarded against by spark gaps and by the use of high non-inductive resistances, such as water, when switching on and off circuits, and in motors and transformers by the use of inductive resistances in series with them at starting; the use of condensers for the same purpose is also increasing. It is, however, to be noted that, as circuits get larger and have more plant connected to them, the effects of resonance gradually become less.

Overhead Mains.

In the more open districts the use of overhead mains is now making some way in this country. While this class of work has been almost universal on the Continent and America, it is only within the last few years that legal and other obstacles have permitted it to be adopted to any extent in the United Kingdom. Now, however, several of the power companies are doing a good deal of overhead work, the costs approximately being about half that for cables; while the overhead wires have the advantage that faults are very easily found and repaired, so that there is less necessity for duplicate lines than with cables. Such circuits are in use up to 30,000 volts in this country. The work is being done in a very superior style and very substantially. I have a number of slides illustrating work of this character, chiefly in the county of Durham, which will explain its characteristics better than can be done except by a highly technical description. The usual spans are 40 to 50 yards, and when crossing roads or railways the live mains are provided with cradles beneath them, to prevent any accidents should a wire break, though the chances of this are almost infinitesimal. Very little trouble from lightning is being experienced, and the modern form of lightning arresters is adequate to deal with any effects which take place.

THE LOTTERY IN ITALY.

The Times recently published some curious statistics on Italian lotteries, furnished by its Rome correspondent:—

The accounts of the State lottery for 1907-1908 show an increase of receipts to the amount of £120,000, or a total of £3,336,000 of gross receipts in the year. Of these gross receipts £1,600,000 went back to the players in the form of prizes, and a profit of £1,736,000 remains to the State after the deduction for expenditure. This is the highest figure that the "Lotto" has yet reached in a year, and more than one newspaper seems to experience searchings of conscience over an increase of revenue from such a quarter.

Certainly a comparison of the local statistics of the Lotto with other figures yields a curious result. One need hardly say, to begin with, that the great majority of the Lotto players are in the south of Italy. The curve of average Lotto play seems to follow roughly the curve of illiteracy. For instance, to take the average of play in proportion to the population of some towns. In Sordrio, the average spent by each inhabitant on the Lotto would be 21 centesimi, the average of illiterates 16 per cent.; Como, 1 lira per inhabitant, 17 illiterates; Turin, 3½ lire, 13 illiterates; Rome, 4½ lire, 43 illiterates; Naples, 14 lire, 54 illiterates. The evidences of thrift are, naturally, in the contrary proportion. In Sicily, where average Lotto play is 10 lire per inhabitant of the big towns, the average deposit in savings banks is 41 lire; this average deposit rises to 120 in Piedmont and 174 in Lombardy. It would seem, too, that the great supporters of the Lotto are the poorest of the poor. More than half of the tickets sold are for sums below fivepence. Tickets of over half-a-crown hardly account for one-tenth of the receipts. The *Stampa* of Turin laments the fact that the State should derive such profit from the most poor and ignorant of the populace. It can at least be urged in extenuation that the case is hardly serious, since the same populace which gambles away £3,336,000 in the year, puts £56,000,000 into the savings bank during the same period. It would be more to the point, says the correspondent, to complain that the State should play with such unfair chances in its favour. A lottery arranged on a scale that leaves it an almost certain winner of half the

money played does not seem particularly just; and that, during the last five years, has been the position of the lotto in Italy. One thing is certain—namely, that the poorer and more ignorant population will gamble in some way or other, and that if the State will not give them an opportunity of tempting fortune they will find opportunities for themselves elsewhere.

In reply to the *Times* writer's comments it may fairly be urged that the lottery in Italy is a source of State revenue, and that so long as the gamblers do not mind taxing themselves to the extent of 50 per cent., there is no reason why the State should not limit the prizes to any amount which serves to attract the gamblers.

THE CUTCH INDUSTRY OF BORNEO.

Cutch is a hard, brown, brittle substance, and when broken presents a smooth shining surface like anthracite coal. It is used for tanning leather and also for dyeing textiles, black or brown. Sandakan has a prosperous cutch factory, which produced and exported 830 tons in 1907 and 970 tons in 1908. Cutch is manufactured in Dutch Borneo and at Mempaked across the bay from Kudat. The cutch is made by these factories from the bark of the mangrove trees which grow in great abundance in salt marshes, extending inland in various places in North Borneo as far back as one hundred and twenty-five miles. The American Consul at Sandakan says that large fleets of small native boats collect and transport the bark to factories. The trees after being stripped of the bark, are, as a rule, cut down, split, and chopped for firewood, loaded into small boats, and finally exported to Hong Kong and other ports. The wood makes an excellent fuel for steam launches. The mangrove bark after delivery to the factory is subjected to the treatment found to be most effective in extracting the tannin and reducing it to solid commercial form. Cutch is by no means a new substance, having been used by the ancients for dyeing a permanent black or brown. It is obtained from many species of the acacia. In India they cut the whole tree into chips, which are boiled until the tannin is extracted; then the exhausted chips are taken out, fresh chips put into the kettle, sometimes with leaves and twigs, and the process repeated until the liquor acquires the consistency of coal tar. It is then poured into moulds, where it hardens, after which it is made into balls and wrapped in the leaves ready for market. Cutch of an inferior quality is made from the Areca palm, also from a plant called gambier, which grows in Borneo. It is made and sold by the natives. The value of the gambier exported from Borneo in 1907 was £1,140. Cutch is also largely produced in Sarawak and Dutch Borneo, and goes to increase the exports of these countries. The vast extent of the mangrove swamps in North Borneo, their easy access and the excellent quality of the cutch produced, promises an increasing trade in this useful and necessary product. As the supply of oak and hemlock bark is constantly growing less in the United States, the demand for cutch will increase. The mangrove trees are said to exist in some of the Phillipine Islands in abundance, but they have not as yet been utilised.

THE PRODUCTION OF KAPOK IN JAVA.

Kapok is an article produced extensively in Java, and many hundreds of bales are exported for upholstery purposes, filling beds, pillows, coverlets, &c. The kapok tree, which grows to a height of 25 to 30 feet, is cultivated at sea level, or at as great an elevation as 2,500 feet, but the best material is secured from trees grown at an altitude of not more than 600 feet above the sea. On the high lands the tree bears less fruit, and yields later in the year; often before the fruit is ripe, the rainy season is on, and the water penetrating the fruit before it is properly ripe, damages the fibre, so that the kapok is inferior to that cultivated at a lower altitude. Rich sandy clay is considered the best soil for cultivation of kapok, and it appears to thrive better when planted near the sea on a fair elevation. The ordinary method of propagating the tree is by setting out cuttings from older trees. It is also propagated from seeds. The trees propagated from cuttings do not have so vigorous a growth as those propagated from seed, neither are they so long lived. The trees grown from cuttings bear fruit in three years, being then in full bearing and ready for harvesting, while those propagated from seed begin to bear fruit after two years. Of course much depends upon the soil and climate. Seed for propagation is sown during December or January—the middle of the rainy season—and covered with a thin layer of soil. The seeds are sown in rows about twelve inches apart. When the young plants are about six or eight inches high, the soil is well cleared from them, in order that they may be well exposed to the sun, as kapok plants require much sun, and must not be kept in the shade. At this stage the plants must be thinned out so that they are at least twelve inches apart. All that is required until the plants are eight months old is to keep them well watered and weeded. Then they can be set out, and should be planted about 135 to the acre if the ground is intended solely for kapok growing. Up to the present time very few kapok plantations exist, and the trees are generally cultivated together with other crops. This does not harm the kapok tree as long as the roots of the tree are free from those of other growths. In planting, the young trees are stripped of all their leaves and cut off to a length of about two feet. This is necessary to prevent the plant from withering at the top. It is often the custom to plant pepper and serih vines near kapok trees and to allow the vines to grow upon them. This, however, has been found to be a great mistake, for nothing should be planted near the trees, which require all the nourishment the soil can give. After

the kapok tree is some four years old, however, such vines may be allowed to grow upon them without harm. The kapok tree begins to yield in two to three years and at its fifth year is bearing its best. At this period an acre of 135 trees should produce about 420 pounds of clean kapok annually. Some well matured trees have yielded as much as 125 pounds of clean fibre a year, but this is rare. The tree blossoms in April or May and the fruit ripens generally the latter part of October or in November, when it takes on a yellowish brown colour, and breaks open. Then the fruit is gathered and before the rains set in, otherwise the water would damage the fibre. In some cases the fruit is gathered before it breaks open, and it is opened and the fibre taken out as soon as possible, otherwise if left too long in the fruit the fibre becomes yellow and loses its glossiness. The seeds are separated from the fibre by beating with sticks so that the seeds fall out. This sometimes causes the seeds to explode and the entire lot of kapok is destroyed by fire. To clean the kapok properly it is laid on a large bamboo grating and the beating process goes on until all the seeds fall through the grating, and the clean fibre remains. A more modern way of cleaning the kapok after it has been taken from the fruit, is by a hand machine, consisting of a horizontal cylinder, the inside of which is lined with rows of pegs placed vertically on the sides of the cylinder. An axle, also fitted with pegs, turns on the inside, and threshes the kapok inside the cylinder, which is put in through a funnel. The cleaned fibre drops out through an aperture, and the seeds drop through a perforated iron at the bottom of the cylinder. This is also a very slow cleaning method, and good modern machinery is much needed in Java. It is stated that 450 of the fruit will give about one pound and a quarter of fibre, and two pounds and a half of the seed. When preparing for shipment, it is packed in bales, covered with bagging or mats and pressed, either by hand or hydraulic power, into bales weighing about eighty pounds. Great care is necessary to prevent the bales from being pressed too tightly, for should this be done the fibre would lose much of its elasticity and value. Oil is manufactured from the seeds, and exported mostly to the Straits Settlements. The residue makes a good fertiliser, containing about five per cent. of nitrogen.

SCIENCE COLLECTIONS AT SOUTH KENSINGTON.

A deputation, representing the principal Scientific and Engineering Societies of London, waited on Mr. Walter Runciman, M.P., President of the Board of Education, on Tuesday, the 13th instant, to present a memorial on the housing of the Science Collections at South Kensington.

Sir William Anson, in introducing the deputation, said that the memorial was most important, not only in itself, but because of the names by which it was supported. No doubt Mr. Runciman was aware of the crowded and unsatisfactory condition of the South Kensington science collections. What they asked was that the collections should have room for rearrangement and expansion. They believed that a site was available, and that if it were taken the Government would not have to provide funds for the purpose. They asked that the museum, which represented the application of science to material, should be placed in the same position as art and natural history by the Government of the country.

Sir Henry Roscoe and other members of the deputation having spoken ;—

Mr. Runciman, in his reply, expressed his appreciation of the great value of the collections, and the need for a suitable building in which they could be properly arranged. He approved of the suggestion that part of the funds of the Commissioners for the 1851 Exhibition might be used for the purpose, and promised to bring the matter before his colleagues in the Cabinet, and to use his personal influence in furthering the objects of the deputation.

HOME INDUSTRIES.

Acts of Parliament and the Working Classes.—From time to time, and irrespective of the political colour of the party in office, the House of Commons puts upon the Statute Book Acts designed to ameliorate the condition of the working classes. Unfortunately, the effect of this legislation is often very different to what was anticipated and desired, and, instead of benefiting the classes it is intended to serve, it injures them, and more particularly injures those least able to look after themselves. We are seeing at the present time a great derangement of one of the most important industries in the country, that of coal, consequent upon the coming into force of an Act of Parliament—the Eight Hours (Miners') Act. The object aimed at here was one with which all generous-minded men must sympathise. It was to shorten the hours of labour of men engaged in peculiarly exacting work underground. But the immediate result has been to bring about disputes between master and man that are by no means settled. In South Wales, indeed, some sort of agreement has been arrived at, but the coal masters and coal workers of Scotland are in hot dispute, and there is some likelihood of a lock-out which may involve the whole coal industry of the United Kingdom. In Staffordshire, again, we have only recently seen thousands of pit lads on strike because, as they allege, and with some show of reason, the Act, whatever it may do for others, is distinctly harmful to themselves. It may be hoped that these disturbances in the coal trade will not end in the acute conflict so many fear, but it may well be questioned whether the Act will not do more harm than good to those it was intended to serve. And so with other

Acts passed in earlier years. They, too, were intended to improve the condition of the working man, but in not a few cases they have had the contrary result, and the sufferers have been the weakest members of the section of workers affected. For example, the Employers' Liability Acts have meant throwing tens of thousands of men out of work, because, apart from those workers to whom employers used to give work, but whom they are now afraid to employ on account of their physical condition, and consequent likelihood of making claims for sickness or disablement, there is a tendency to increase labour-saving machinery to combat the heavy disbursement of insurance premiums. To take an illustration from the shipping trade. Many a sailor is now unable to find employment because he is medically unfit to pass an examination which owners must insist upon to safeguard themselves against unscrupulous claims being made. Again, the compensation to domestic servants has been a serious misfortune to the older and weaker class of workers, who can no longer get employment. Employers who were content in the old days to put up with some physical weakness, are no longer prepared to do so, having regard to the heavier liabilities resting upon them. It is not, of course, suggested that Parliament should cease to pass measures for the amelioration of the condition of the workers—far from it—but it is well to point out how necessary it is that there should be exhaustive discussion of proposed legislation, and discussion by men with practical knowledge of the particular trades affected, before existing laws are repealed or modified.

Electric Lighting Amendment Bill.—Considerable dissatisfaction is being expressed by some of those who desire to see the electric industry of the country advance more rapidly than it has hitherto done in connection with the Electric Lighting Acts (Amendment Bill) now before the House of Commons. It is contended that this Bill does not touch the weakness of the Electric Lighting Acts of 1882 and 1888, or, if it does so, it rather increases the objectionable features of those Acts than removes them. Some eleven years ago a Joint Committee of both Houses, of which Lord Cross was Chairman, recommended among other things the abolition of the municipal veto on electric supply schemes. Four years later the Institution of Electrical Engineers sent a deputation to the Board of Trade urging changes on the lines laid down by the Joint Committee, and the then President of the Board of Trade stated that a Bill had been drafted to give effect to the suggestions of the Committee. In 1903 the Bill was printed, and in 1904 it was considered by a House of Lords Committee, amended, and passed through the Upper House. Nothing more was done with this Bill, owing probably to the change of Government which took place in 1906, and it was not until the present session that the Government again took up the matter. The result is the Electric Lighting Acts (Amendment Bill) now before the House of Commons. It is a measure very different from the Bill drafted by the late Government on the lines of the Cross Committee. There is, for example, no provision for the modification of the veto, or the relaxation of any one of the worst restrictions upon private enterprise and electricity supply. The Bill has already passed through the House of Lords, and the Government are making a determined effort to get it through the House of Commons, but it is feared that if it becomes law the spirit of the Electric Lighting Acts of 1882 and 1888 will become dominant for an indefinite period. Moreover, if the Bill passes it is argued that one of its principal effects is likely to be the strengthening of local authorities in their competitive and other relations with electric supply companies. It is held by the opponents of the Bill that it will, both by what it enacts and what it fails to enact, do nothing towards encouraging the investment of capital in the electrical supply industry, but rather the contrary. Of course, this is only one side of the question, but it is much to be hoped that Parliament will do nothing to discourage still further private enterprise in electrical matters.

Coal Exports.—The volume of our foreign coal trade during the six months ended June last was greater than for the first six months of 1908, the actual quantities sent abroad being 30,421,691 tons, as compared with 30,024,552 tons in the corresponding period of last year, an increase of 397,139 tons, equal to 10 per cent. Prices have fallen heavily both in the home and in foreign markets, and in South Wales the fall in the export prices of steam coals has been greater than in any other class of fuel owing to the effect on average f.o.b. quotations on the prices of coal shipped under contracts. In the average f.o.b. price Cardiff large steam coals, there has been a drop approximately of 2s. 7d. per ton. The activity in May and June was due largely to the prospect of labour troubles leading to a stoppage. Foreign powers were also alarmed, and pressure was brought to bear on the collieries by coaling companies and foreign companies, and the Admiralty, to expedite delivery of contract coal. The temporary increase of current demand over current supplies drove up market quotations from 5s. to 6s. per ton higher than those prevailing up to the end of April; but the settlement of the labour crisis was followed immediately by a relapse to the old level, and it is quite possible that prices will go lower before the end of the year. It may be expected that business will be considerably less active in the second half of the year, and the effect of the Eight Hours' Act upon output price and export has still to be made known. On the one hand it is believed that the reduction from 54 to 48 hours in the number of hours to be worked per week in the South Wales coalfield will have a serious effect, whilst on the other hand it is expected by some that the reduced hours will be counterbalanced by fewer absentees, an increased efficiency of labour, and improved methods of working. It is

only by experience of the actual operation of the Act that it will be known which view is the correct one.

Fishguard and the Cunard Company.—It is believed that the Cunard Steamship Company have it in contemplation to make the Pembrokeshire port of Fishguard a port of call. Now that the London and North-Western Railway Company is in closer contact with the White Star Company, owing to that line having made Holyhead a port of call for their inbound Liverpool steamers, the Cunard Company naturally wishes to strengthen its position by a similar alliance with the Great Western Railway Company. The distance between New York and Fishguard is 2,902 miles. It is nearer to New York than is Holyhead by 40 miles, than Liverpool by 110 miles, than Southampton by 175 miles, and than Plymouth by 55 miles. Trains can easily be run between Fishguard and London in 4¼ hours, as against 5¼ hours between Holyhead and London, and 4 hours between Liverpool (riverside) and London. It is only fifteen months since the potentialities of Fishguard as an ocean passenger port were first tested. Since then, all the Booth line passenger steamers have called there. Alongside the breakwater, there is space for quay accommodation for vessels 790 feet in length, the length of the *Lusitania* being 780 feet. The inner harbour is almost entirely protected by the quays and breakwaters, and contains an anchorage area of 85 acres, which is being dredged to a uniform depth of 40 feet, the bed being soft and rockless.

Workmen's Compensation and Insurance Companies.—The tariff insurance companies are about to raise their premium rates for workmen's compensation business in the cotton trade. The proposed new rates are 20s. for £100 of wages paid for mule spinning, 10s. 6d. for ring spinning, and 4s. 6d. for weaving. A large number of firms in the cotton trade are insured through the Federation of Master Cotton Spinners' Associations, the Blackburn Cotton Accidents' Company, and the Cotton Trade Accidents' Association, of Manchester, the latter being practically a mutual association of about 100 firms, the premium rates being 10s. 3d. for mules, and 3s. 3d. for rings and looms. A number of insurance companies are about to forward a memorandum to the Government directing attention to the limitations of the Assurance Companies' Bill. It will be urged that the requirements as to deposits which apply to all companies transacting life assurance should be applied to all existing fire and accident companies, as well as to companies which may be established in the future for the purpose of transacting these classes of business. The memorandum will also direct attention to the fact that the Bill contains no definition of an underwriter, and suggest that a minimum equal to 33⅓ per cent. of the premium income should be stated in the Bill as the reserve to be set aside by all companies for unexpired liability in respect of fire, accident, and employers' liability risks.

GENERAL NOTES.

ELECTROLYSERS IN LAUNDRIES.—In German hospitals the electrolytic treatment of soiled linen is already very general, but hitherto in this country the treatment has not been adopted. Now, however, the Manchester Infirmary has begun to use that invented by Haas and Oettel. The construction of the apparatus is simple. It consists of the electrolyser proper made of stoneware, a brine dissolver of wood provided with an agitator, foot valve and let-off tap; a stoneware collecting tank, and the necessary switchboard. In operation the brine dissolver is filled with a measured quantity of water, to which is added a given weight of common salt, which is dissolved by a few turns of the agitator. As the brine is allowed to run through the electrolyser the electric current is turned on, the result being an electrolytic liquor of constant strength. The liquor runs into the collecting tank below, from which it is withdrawn for immediate use. The amount of electric current employed is very small. Chlorine is one of the most powerful disinfectants known, and is also the most perfect bleaching agent. By means of these electrolysers neutral sodium hypochloride can be produced in all strengths from 3 to 14 grammes per litre. It is said that one of the advantages of the system is that clothing may be treated with it week after week without being injured.

INSURANCE OF EMPLOYÉS IN GERMANY.—In his report on the trade and commerce of Westphalia and the Rhenish Provinces, just issued (No. 4283, Annual Series), Mr. Consul-General Koenig refers to the new law for the insurance of *employés*, and says that it lies very heavily on the shoulders of employers, as the latter have to pay half the legal contributions towards insurance. Besides these burdens there are to be new regulations issued as to compulsory contributions against illness, increased waterway and canal dues, reduced hours of labour in certain trades, a general widow and orphan insurance, and increased telephone charges. It is, the Consul-General considers, very questionable how much more trade and commerce can be conveniently burdened without hampering their very existence. Statistics show that the wealth of Germany has increased, but the very large increases of late years resulted from exceptionally good times and large turnovers, and not from interest on capital invested. It is a remarkable feature of the times in Germany that it is becoming an absolute necessity for German Ministers to meet in conference representatives of the banking interest, and of the many syndicates, in order to talk over commercial, industrial, and economic matters. The result of such meetings of the Government with representative deputations promises to be of far-reaching importance in influencing the legislation of Germany in the interests of the trade and commerce of the Empire.

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All communications for the Society should be addressed to the Secretary, John street, Adelphi, W.C.

NOTICES.

"OWEN JONES" PRIZES FOR INDUSTRIAL DESIGN.

This competition was instituted in 1878 by the Council of the Society of Arts, as trustees of the sum of £400, presented to them by the Committee of the Owen Jones Memorial Fund, being the balance of subscriptions to that fund, upon condition of their spending the interest thereof in prizes to "Students of the Schools of Art who, in annual competition, produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones." The prizes are awarded annually on the results of the national competition of the Board of Education, South Kensington.

Six prizes were offered for competition in the present year, each prize to consist of a bound copy of "The Leading Principles in Composition of Ornament of Every Period," from the "Grammar of Ornament," by Owen Jones, and a Bronze Medal.

The following is a list of the successful candidates:—

Cheetham, Humphrey, School of Art, Macclesfield. Designs for Printed Velvet Hangings.

Cope, Fred., School of Art, Macclesfield. Design for a Tea-Table Cloth.

Heaton, Samuel, School of Art, Shipley. Modelled Design for a Wall-filling.

Hirst, Joseph, School of Art, Macclesfield. Design for a Tapestry Hanging.

Malins, Louis M., School of Art, Macclesfield. Design for Furniture Silk.

Mason, Arthur, School of Art, Macclesfield. Design for Figured Silk Dress Material.

The next award will be made in 1910, when six prizes will be offered for competition.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE PUBLIC SUPPLY OF ELECTRIC POWER.

By G. L. Addenbrooke, M.I.E.E.

PART IV.*

Extension of Supply Mains over a District.

In laying out a distributing system, the point to aim at is to arrange this as far as possible in loops, so that every customer may be approached in two ways, while there is as little duplication of cables over the same route as possible. Cables should be looped where practicable into customers' factories in preference to making T joints, as in case of faults loops are much more easily dealt with; and if the loop is complete, when a fault occurs, only the damaged section need be cut out, and all the customers can be kept supplied from one or other end of the loop while repairs are carried out on the faulty section.

The remaining important factors in the distributing system are the transformers. During the last few years the discoveries of new alloys of iron, in which the losses are little more than half those previously usual, have enabled great improvements to be effected in transformers and higher efficiencies to be attained. The no-load losses in the class of transformers used generally in power supply do not exceed 1 per cent., and the efficiency of the transformers under load will average about 97½ per cent.; when transformers are used in works at sub-stations, they can also often be cut off when not required, and in this way the transformer losses in such systems can be kept down to a very moderate figure.

* The Course consisted of three lectures, delivered on January 18 and 25, and February 1. In re-arranging the material for publication, the lecturer has preferred to divide it into four parts.

The cost of transformers themselves is also very moderate. The smaller types cost about £2 per kilowatt, 50 kilowatt transformers about £1 10s., and 100 kilowatt sizes about £1 per kilowatt, while larger sizes such as 400 to 500 kilowatts will not average more than 10s. per kilowatt. It not infrequently pays under these circumstances to use double transformation when a number of small customers have to be served, reducing the pressure first at a sub-station from 20,000 or 10,000 to say 3,000 volts, and distributing to the individual customers at this pressure. In this way a considerable simplification and reduction of costs of the customers' switch gear can be attained, and complication of the main high-pressure circuits is avoided. The laying out and arranging of local distributing systems is one of the points in power supply which calls for the best exercise of judgment and discretion.

Waste Heat Stations.

The supply of energy into the same distributing system by subsidiary power stations located at different convenient points has already been mentioned as having been employed by the Newcastle and its allied companies on a considerable scale. This is a development which will undoubtedly be utilised more extensively in the future, as it is found that stations situated widely apart can be effectually arranged to work in parallel supplying into a single network.

Such stations are advantageous in at least two ways. In the first place, if there is any point where waste heat in the form of gas, whether from coke ovens or blast furnaces, is available, or exhaust steam for use in low-pressure turbines, or dust from dust destructors, the cheap supply of energy can be taken advantage of. Again, each local station, if situated on a looped main, enables a greater amount of power to be supplied with the same network than if the supply was from a sub-station, thus becoming an important factor in reducing the cost of the distributing system per kilowatt. When possible, such local stations are best kept in operation continuously, variations in the supply being taken up by the main controlling station, which also, in case of breakdown of the local plant, can maintain the service uninterruptedly. But they may occasionally be used with advantage for peak loads. As an instance, the Charing Cross Company are using the Diesel oil engine, situated at various points in their supply mains in the City, for the purpose of meeting sudden loads due to fog and the heavy peak loads they get at other times. Their value in this case is in preventing falls of pressure in the local distribution system, and in saving the capital cost of mains in a place where they are so expensive and difficult to lay as in the City. For this reason it is not necessary, as a rule, to install spare plant in the local stations which are thus cheaply constructed. As networks grow it will pay occasionally to install such stations even when the power has to be generated in the ordinary manner. By the help of the telephone subsidiary stations can be worked almost as easily as if they formed part of the main station.

Location of Faults.

One of the most important things in connection with a distribution system is to arrange that, on any fault occurring, its effects shall be localised and its position shall be indicated in the shortest possible time. A number of different schemes for effecting these objects have been devised, of which the chief involve the use of time-element cut-outs, or of balanced transformers, the most complete system in the latter case being known in this country as the Merz-Price.

In the time-element system, at each sub-station there is an oil switch on each side of the loop. This oil switch, when closed, compresses a spring, and the handle is kept in place by a catch. This catch can be released by the action of an electro-magnet, round which flows the main current or a current taken from a series transformer in the main.

The electro-magnet has an armature, to which is attached a clockwork mechanism, or a simple graduated fuse may be used instead. If the current in the circuit exceeds some given amount, the clockwork is set in motion or the fuse ruptures. In either case the action takes place in some predetermined time, after which the catch is released by the movement of the armature and the switch is opened automatically.

This arrangement cannot be worked with a closed loop, but if two lines forming a loop are cut at some point, the time of action of the circuit can be graduated, keeping the longest action near the power station. Then, if a fault happens, the line should be broken at the farthest sub-station from the generating station which is on the near side of the fault. If, then, a no-voltage release is placed at the end of the main it can be arranged to throw over the undamaged portion on to the second

main, though the remaining portion of the circuit on the faulty main will then have its time-element cut-outs in the wrong order, and this may necessitate resetting them before the main can be used. This arrangement, while of considerable use, especially on single cables, is therefore by no means perfect, particularly in complicated systems; the action of the cut-outs is also liable at times to irregularity due to resonance effects or sudden short circuits.

Balanced Transformer System of Mains Protection.

The balanced transformer system of protection is much more perfect though more expensive, since it needs a small three-core pilot cable alongside the main cable between each two sub-stations; it will, however, I think, be adopted on complicated networks in future, as it has the great merit, if working properly, of cutting out the faulty section only, so that, if each customer is on a loop, a fault merely cuts out the faulty section on one side of him and all the customers' services are kept going. Further, it is applicable to working with a closed loop, and it should also locate the faulty section at once, obviating the delay of testing long lengths of cable for a fault and enabling the repairing gang to proceed without delay to the faulty section and start repairs. Lastly, each section being complete in itself and independent of other sections, it can be applied to large systems without increased complication.

Briefly, the action of this arrangement is as follows:—On the three main circuits entering and also leaving any sub-station three series transformers are placed, the secondaries of which are connected to three pilot wires which are carried in the cable trench to the next sub-station, where they are joined up to the secondaries of another set of three series transformers, but arranged so that the pressure is in opposition to the first set. As long as the main cable is perfect the same current will evidently flow through both sets of series transformers, and consequently no current will flow through the pilot wires. If, however, a fault of any kind, whether by going to earth or short circuit, occurs on the main cable, the current flowing through one or more pairs of the series transformers will differ, either being in the same direction or one being greater than the other, if the direction of the current is maintained; a current will then flow along one or more of the pilot wires. Any current flowing through these pilot wires works a relay at each end, and thus operates the oil switches, which are maintained closed by a spring and cam, as when using time-element cut-outs. The oil switches at either end of the section then open, and the faulty section is cut out.

Except for the expense of the pilot wires and transformers it is difficult to conceive a more perfect arrangement than this, although it wants some care in operation to obviate the effects of resonance, should such be set up; its use, however, constitutes a most important advance in the protection and operation of heavy and complicated main circuits. For the protection of customers' circuits and circuits of less importance, another form of automatic cut-out which is cheaper and more compact is coming into use. This consists of two or three electro-magnets erected on the poles of the oil switch, and surrounded by solenoids through which the main currents passing through the switch flow. The cores of these electro-magnets attract an armature, and if the current exceeds a given amount, the armature moves and releases a cam by which the switch is released, and the current interrupted.

A time-element can be added to prevent too sudden a movement of the armature. On account of its compactness and cheapness, as compared with the use of series transformers it is probable that this arrangement will have extended uses in the future.

Switches and Sub-station Gear.

The oil switches and switch gear which are used on the feeders, and at customers' sub-stations, take many forms, each manufacturing company, as a rule having its own type. Most of these types are well known.

Speaking generally, a customer may be connected to the network by a single branch line, by a looped-in cable on a single line, or by a looped-in cable on a loop, and their connections may be made directly off the main feeders or may proceed from the sub-station having a subsidiary network.

A single branch line is usually called a T-junction. In this case the arrangements are very simple, consisting of an oil switch with automatic electro-magnetic cut-outs attached to the switch and operated by means of series transformers inserted on the incoming leads and acting on the switch.

Sub-stations and most consumers of any size are, however, usually connected to the circuit by looping a high pressure feeder into them, and then the arrangements have to be more

elaborate. The usual way of doing this is to provide an oil switch, on both the incoming and outgoing feeders. These switches are fitted with automatic cut-outs or protection gear, either of the time-element or the Merz-Price type as already described, the connection to the customer being taken from the conductors joining the switches, which really form bus-bars. This connection should also be provided with an automatic cut-out itself, so that the local installation may be cut off the supply mains, or may be fed from either direction in case of accident.

A great deal depends on the design and proper operation of this switch gear which is rather expensive. One of the most desirable improvements in power supply practice is the standardisation of this class of work, its simplification, and its cheap construction while insuring efficiency.

In most cases the connection work for this purpose in the sub-stations or on customers' premises is carried out with bare copper rods or with cables, and separate pieces of apparatus are assembled for the purpose; but Messrs. Reyrolle and Company who have had the experience of the Newcastle Company to guide them have lately introduced a form of switch gear in which the whole of the arrangements are standardised and rendered very compact.

The chief points about it are:—

1. The omnibus bars and connections are surrounded by solid insulating material poured over them after everything is joined up, which enables the connections to be placed much closer together than if they were in air.

2. The whole gearing and connections are encased in iron which is put to earth and thus any chance of shock is obviated.

3. The switches and instruments are on a movable carriage, so that if anytning goes wrong they can be drawn out at once and replaced by another set while the first set is sent for repairs.

This switch gear is often located close to a wall in a closed room and the switches themselves are arranged so that they can be operated from the other side of the wall.

Electric Energy at the Consumers' Premises.

I have already stated that there are about 600,000 horse-power of motors installed in works in this country, and supplied from public supply stations, while the horse-power of motors driven by private generating plants is probably considerably in excess of 1,000,000. A return just published for the United States puts the motors installed there on similar public circuits at 1,649,000 horse-power in 1907, and as this had increased from 438,000 in 1902 it will be seen that the rate of progress has been equal to 276 per cent. in five years. The United States total is, therefore, about three times that for this country. It is true that the United States population is double ours, but a much larger proportion of the people live in rural districts. Taking this into consideration the use of electric motors in factories supplied from public stations is, therefore, at least double in the United States what it is here, showing the large opening there is for increase in this respect.

I cannot hope to review here the immense field for the employment of electric driving in factories, but on the principle of the greater including the less, I propose to devote a short time to the consideration of electric driving in industries where the adoption of the electric motor has been considered to offer the least advantages.

The industry which has always been considered the most difficult for electric motors to replace mechanical driving has been the textile, particularly cotton-spinning and weaving. Although, however, in mills fitted with modern engines of considerable size, not much gain in actual cost for power may be shown, the advantages of electric driving in other ways are such that it is paying to make the change, and when this is being done the question of whether the supply should be made on the spot, or whether it shall be obtained from a public supply station is largely one of relative cost, and that, as we have seen, is dependent in a great measure, other things being equal, on the scale on which the local supply undertaking can be operated. The great gain in this industry experienced from electric driving is in the first place the regularity of rotation of the motor and its instantaneous response to the imposition of a heavier load. For instance, the three-phase motor ordinarily has a slip of 4 to 3 per cent. when heavily loaded—depending on its size, but the increase of the slip by 1 per cent., which ensures a 1 per cent. fall in the rate of revolution, will probably nearly double the torque which the motor exerts. In machines driven by shafting, not only is there the greater irregularity of the engine, but there is considerable whip or spring in the shafting, and slip of belts when working, and this increases

or decreases as the load varies. In textile work the rate of working is limited by the breaking of threads, and it is obvious that any irregularity when the threads are nearly at their maximum strain will result in rupture. With a more even and steady drive it is found possible to speed up machines 5 or 6 per cent. without incurring more breakages and consequently while increasing but little the cost of attendance.

I cannot afford to devote further time to chronicling examples of the use of electric driving in other industries, but two special applications which are attracting attention at present may be noticed, namely, main haulage for collieries and the driving of rolling mills.

A further interesting development is the design of single phase motors which can be operated from one phase of three phase circuits, and which by movement of the brushes on the commutator of a short circuited armature can be made to vary their speed through a range of some 50 per cent. These are being mechanically coupled to the machine they drive so that the speed can be automatically varied at different stages to suit the operations being conducted. This development of the single-phase motor removes one of the last objections to the employment of alternating currents, namely, the difficulty of providing variable speed motors without excessive expense or undue losses in running at certain speeds.

Probable Developments.

In what I have said so far I have confined myself to what is actually being done now, and I have assumed that progress will be on the lines of present practice, as this is the only safe ground to work on; but when large sums of capital have to be laid out at a time when knowledge is advancing in several parallel fields it is advisable to look ahead to what may be done in perfecting the system of power supply which we are considering, and also to consider whether progress in other directions is likely to alter the situation.

Let us take the last of these points first. When public electric supply is once established, the only conceivable way in which it could be superseded would be by some very cheap and simple form of prime mover operated on the spot. But it is gradually becoming clear that the greatest advantages of power supply from a central source are the regularity of the drive, the fact that scarcely any alteration in the speed of motors is made by throwing heavier loads on them, the gain in the amount of plant required at the station by grouping, and lastly, that with power supply the facilities are always at hand for obtaining an extra amount of power at short notice.

Again, with power supply the customer is put to only small capital expense to obtain his power. For instance, 10 horse-power motors are now procurable, including starting gear, for £3 10s. per horse-power, while 50 horse-power motors, complete with all accessories, will only average about £2 10s. per horse-power, and larger sizes cost even less than this. No small engines situated locally could give these advantages.

Supposing a very simple and cheap running engine were discovered, it would usually have to be connected to a dynamo for works supply, and even if it were used direct its cost would almost certainly be in excess of electric motors, while the attention it would require would be much more.

It is true that there is the alternative of supplying gas for motive power to consumers, but this has the fatal defect of landing the consumer with a heavy capital cost of engines and dynamos, and all the trouble of looking after the plant.

Lastly, if any very simple form of engine were discovered, and one which was cheap to run, the probability is that it could be still more cheaply built and run in large sizes, and would therefore be used in the central station itself.

It must be recollected that the distributing system is very fairly efficient in a well laid-out power undertaking, and the average losses in it ought not to average more than 16 per cent., and probably in future even this will be gradually improved upon as loads become heavier, and networks can be laid out to better advantage. The full load losses again do not average 10 per cent. even now up to the consumer's motor. Moreover, the depreciation of cable systems is very small, while the efficiency of customers' motors is high; whatever changes, therefore, there may be in prime movers, and probably they will be great, it does not seem likely that anything will interfere with the use of electric power in factories, or with its provision by means of distributing systems, such as we have been considering, though these may in themselves be greatly improved in the future.

The position, therefore, is commercially

stable except for this question of prime movers. In this department, steam turbines are for the moment in the ascendant, yet the gas engine is treading on their heels, and the question arises whether it would be better to wait before making developments on a large scale, to see what progress is made in this direction.

The Use of Steam or Gas Plant.

On this point, I would first of all like to say that if changes in prime movers are to be made later in customers' works, or alternately in a central station, it will, looking at the matter in the broadest light, be better to make the change at the central station, because, as we have already seen, probably only half the horse power of plant would require to be changed in the central station that would be necessary if consumers' plants had to be changed, and secondly, the cost per horse-power would undoubtedly be cheaper for large sets than if the horse-power were split up into small sets, situated at consumers' works. The prime mover question therefore is narrowed down to the advisability of using steam plant or of waiting a further development of the gas engine.

Now, I have already discussed the efficiency of steam plant in my last lecture, and I pointed out there that while there is probably not much chance of the efficiency of steam turbines themselves being improved very considerably, yet there is room for some improvement, and that there are still openings for very considerable economies in the boiler-house. On the other hand, if gas engines and producers are to be employed in central stations, there is still a good deal of detail work which must be done on them to render them sufficiently reliable and suitable for the purpose.

Now, the same amount of ingenuity and skill spent on improving turbines, and particularly boilers and their working, would, in my opinion, lead to economies which may, I think, be fairly put in the neighbourhood of 25 per cent. over the best present day practice. These economies are chiefly obtained by :—

1. Savings in banking boilers or firing up.
2. Reduction of radiation losses.
3. Better regulation of air supply.
4. Taking more heat out of the gases, as by use of hot-air supply.
5. Higher degree of super-heat.
6. Improvements in auxiliaries.
7. Further economy in the turbine itself.

It is, I think, quite possible that more than this can actually be done, but it is necessary to bear in mind that increased efficiency is usually accompanied by increased capital cost and complication in working, and after a certain point the burden of these may outweigh an actual gain in efficiency considered by itself.

There is little doubt that boiler-makers and others interested in steam plant will not give up the struggle without considerable efforts in this direction when once the situation becomes seriously threatening, and having regard to the almost ideal conditions under which steam plant can now be operated in large central stations, it is pretty certain that improved economies on the lines indicated will be forthcoming, especially as the working conditions in such stations will be better adapted for practising economy than they are now in the first years of this class of enterprise. Nevertheless, when all is said and done, I think it likely that the internal combustion prime mover may come forward more quickly than seems now probable on the facts of the case themselves, owing to fashion, which has a great influence in these matters. To effect such improvements as we have been contemplating in steam practice will need much energy and perseverance, and the attention of the best minds, extending over a considerable period; but if there arises an idea that any cause is a losing one, there is a great tendency for the best minds to desert it, and for other people to go in for new developments, because they think they are the coming thing. This has already occurred once or twice in the electrical industry, and it is a point to which I would seriously call the attention of manufacturers interested in steam plant. Considerable improvements are to be made in the direction indicated, particularly in the boiler-room, but if their initiation is delayed too long, the time for taking them in hand may have gone by. The chief factor in the situation, therefore, is the development of the internal combustion engine.

Gas Engines and Producers.

Gas engines are now made up to 4,000 horse-power, and when we know that as much as 500,000 horse-power of such engines is being used in Germany alone at the present time, and when we also recollect that the thermal efficiency of these engines is approximately twice that being got out of steam plant at present, many people wonder why they have not already been adopted for central station work to any extent. There are, however, several reasons for this. The great develop-

ment of the use of the gas engines has been in connection with the use of blast furnace gas, a gas which, when it can be obtained, is regular in quality, has already had the impurities extracted from it in the furnace itself, except dust, and is peculiarly suitable for use in such engines.

To produce gas from the ordinary qualities of bituminous coal in a producer and to be sure of obtaining it of even quality, and to free it thoroughly in the cleaning plant afterwards under all circumstances from tarry matter in suspension, is by no means an easy task; in fact the obstacles to the use of large gas engines at the present day lie even more in obtaining thoroughly satisfactory producers and cleaning plant than in the engines themselves. A producer and cleaning plant which will work well on one class of coal cannot be relied upon to give the same results if the coal is changed. If thoroughly satisfactory producers were forthcoming which could be relied upon to give with management of ordinary intelligence an even quality of gas free from impurities under the varying circumstances of a central station load and with varying kinds of coal, it would not be long before we should see the gas engine working in parallel with the steam engine or turbine and taking up the more continuous part of the load in power stations. It is really the producer question which to a considerable extent is holding back the gas engine for central station work, and also the fact that gas plant is more costly than steam to install in large sizes.

Nature of the Economies obtained by the use of Gas Engines.

Let us consider what is likely to be the influence of the use of such engines in central stations assuming they can be employed. If we turn to the Tables of working expenses which I gave in my last lecture, and if each of the different columns is considered it will be found that the only heading under which the use of gas engines would give an advantage is that of coal cost. At present both the labour bill, the cost of oil and stores and the repair bill would probably be considerably increased if gas engines were used, but we will assume that progress will improve matters as regards these items.

Coming then to consider the coal bill, as things stand at present it does not look as if the saving in the quantity of coal used to produce a certain amount of energy would be more than 40 per cent., which at the price of coal taken in the Tables would mean that energy could be supplied from such stations as we are contemplating 10 per cent. cheaper than if steam plant of present-day efficiency were used for ordinary load factors, and about 20 per cent. cheaper where the load was continuous. Against this we have the fact that at present the cost of gas engines and producers, including foundations and buildings, is something like 25 per cent. in excess of the cost of similar steam plant, and when we add to this a larger sum for repairs and for oil and stores, it will be seen that at present the incentive to the central station engineer in districts where coal is cheap to adopt gas plant is not great, and would not make much difference from the consumers' point of view. It must also be recollected that there is a certain reluctance amongst central station engineers to adopt the gas engine, because it is in itself, when coupled to a dynamo working at relatively low speed, an inferior appliance for doing the work with its slow speed and small capacity for overload to the high speed steam engine and more particularly to the steam turbine.

The economy of using the gas engine will of course be much greater in districts such as London and on the banks of the Thames, and in other similar places where much power is used, and where the price of coal is much higher than in the industrial districts near the coalfields, and it is in such localities that the gas engine will no doubt come into use first for central station purposes. As its advantages are greatest when used for the long hour loads it seems certain that it will make its way into central station working for this purpose, being coupled in parallel with steam plant, which latter is better adapted for taking up variations in load, and the large overload capacity of which could be used for carrying on supply in case of temporary failure of the gas engine.

For small stations there is already a strong bias in favour of gas plant or the use of the Diesel oil engines. For larger stations the change from steam to gas driving will only come gradually especially if the possible improvements are made in steam practice, and when it comes it will be introduced at first to supplement steam-driving and to operate in conjunction with it.

It must be acknowledged that owing to the rise in the automobile industry, and for other reasons, an enormous amount of time and attention is being devoted to improving the internal combustion engine, and the chances are

that in the long run it will win the race, as it is impossible to conceive that in these days of advance engineers will remain satisfied with a prime mover which, however perfect mechanically, cannot be made to give a thermal efficiency of much more than 15 per cent. of the energy value of the combustible used.

To adapt the gas engine successfully to central station work, it appears to me that progress must be made on the same lines as those on which it has taken place in the automobile industry, that is by the use of four to six-cylinder high-speed engines, a type of engine which, as a matter of fact, the Westinghouse Company have been making for some time.

While the adoption of the gas engine cannot, from what has been said, make a great difference in the price at which energy can be supplied to ordinary hour consumers in industrial districts, it is worthy of note that a 40 per cent. saving on the coal bill would provide a margin sufficient to increase the sum assigned for distribution as interest on the capital employed by 20 per cent. and thus would give the ordinary shareholder in a company a fair dividend instead of a meagre one, and this of course will be a powerful incentive in securing their adoption, as soon as engineers have sufficient confidence in them.

The adoption of gas engines operated by producer gas is, however, not a step to be taken without very full consideration even after being satisfied with a type of gas engine and producer. The manufacture of producer gas on a large scale must be considered with reference to the site on which it is to be conducted. It is impossible at times to avoid unpleasant odours, and a good deal of tarry liquid is produced from the cleaners, which is intractable, while sanitary authorities object to its being passed into streams or sewers. It must, therefore, be dealt with usually on the spot, and proper arrangements, including a considerable amount of space, are necessary for this. Altogether, as the process is conducted at present, the manufacture of producer gas from bituminous coal is not a thing which can be undertaken in densely populated neighbourhoods without considerable risks of actions for nuisance.

The Legal Position.

It is difficult, especially for a layman, to present in a clear light the present position of matters and the need for reform.

It must be premised that, as the industry of power supply as well as lighting supply necessitates making use of the roads or the crossing of them, it is absolutely subject to legislation which can affect its development and progress to such an extent as to defeat the best engineering and commercial proposals, or delay indefinitely their being carried out, and alternatively may lead to much capital being spent in other directions than the best.

It is therefore peculiarly important that legislation affecting the industry should be well considered and up-to-date, and that it should even if possible anticipate the probable lines of progress.

Method of obtaining Legal Powers.

Notwithstanding this, most people are aware that to obtain powers to give electric supply for lighting, recourse must be had to the system of proceeding by Provisional Order under the Electric Lighting Act of 1882, which was passed when it was considered impracticable to supply electric energy for such purposes to greater distances than half a mile, and when the use of electric energy for other purposes than lighting was hardly thought of seriously. Nevertheless, the lighting Provisional Order is held to cover full powers for power and heat supply, and outside the Power Acts, and a few Acts obtained by the larger local authorities, all electric supply work has so far been done under it. Although, as we have seen, it is now difficult and inadvisable to develop power supply separately, the Power Acts only give power for electric power supply and for lighting to such consumers as take a supply for power.

For lighting any district a Provisional Order must, therefore, be obtained, in addition to any powers obtained under a Power Act. Now, when obtained, such a Provisional Order also covers powers for power supply, so that if the Provisional Order is obtained by third parties it enables competition in power supply to be set up; and, on the other hand, if it is held by a power company, and they do any lighting under it, it is uncertain how far their system may become purchasable under the purchase clause of the Electric Lighting Act unless the two systems of distribution are kept quite separate—a needless expense and complication. There are other difficulties arising out of the Power Acts, such as the impossible scheme of finance forced on them by Parliament, which is so out of date and absolutely unsuited for an undertaking of this character, that it has led to the curious result that, in the

case of most of the power companies, another limited company has had to be formed to hold the Parliamentary company in trust, entailing double registration fees and heavy legal expenses, besides a great deal of unnecessary complication.

Veto of Local Authorities.

Another point is the absolute veto of the local authorities in so many cases without power of appeal to any tribunal, which leads to negotiations being often dragged out to great length, and not infrequently to very desirable developments being entirely blocked. Theoretically the Board of Trade can override this veto in some cases, but they are usually so subservient to local authorities that this theoretical power is of little moment.

The Acts of 1882 to 1888.

The chief legislative obstacle to electric progress in this country at the present time is, however, undoubtedly the Act of 1882, where private enterprise is concerned and the modified purchase clause of 1888. By the Electric Lighting Act the unit area for supply is usually the area of a local authority, whether borough, urban or rural district.

Working of the Act.

In a large number of such areas scattered promiscuously about there are electric undertakings, established in the provinces for the most part, in the hands of the local authorities. Where these are established their vested interests must of course be considered, and it is difficult to alter the conditions under which they were set up, but there are still numbers of towns of moderate size and populous districts scattered over the country where no electric powers exist, and where, if electric supply is to be given, whether by power companies as part of a large system or independently, it can only be done profitably on the basis of a combined power and lighting supply. They are a class of district where the local authorities are unlikely to proceed themselves and yet where a combined lighting and power supply would be of advantage, and comprise many industrial areas. In all these cases the incidence of the purchase clause bears very hardly. I would point out that the terms of this are the same whatsoever the nature of the district to which a Provisional Order relates. The terms of purchase are the same for the companies operating in the richest districts of London and for places in the country where it may barely pay to do lighting at all, although it is to the interest of such districts that lighting supply should be encouraged.

Let us take an example. From the figures it will be seen that the gross revenue of supply undertakings when fully in operation will probably be less than one-fifth of the capital expended, and in the case of lighting the return is often less. That is to say, the capital will only be turned over once in five years at the most. But such undertakings will seldom have their full capacity taken up, and they have nearly always to provide plant in advance of requirements, to meet probable extensions. Again, there are the initial stages while the business is being built up; thus, if we take an average, the capital will in successful undertakings not be turned over probably once in seven years, or six times during the 42 years which constitutes the term of the concession, under a Provisional Order. Now it is very indeterminate what price would be paid in the event of the local authorities purchasing, as they have power to do in the case of Provisional Orders, but I understand legal authorities contemplate that the price to be paid under the purchase clause would not exceed 60 per cent. of the capital of the undertaking. Consequently, besides providing for depreciation and contingencies in the case of power and a lighting supply conducted under a Provisional Order, a fund should be accumulated in addition during the term of the concession totalling 40 per cent. or more of the capital, and this while the capital is only turned over about six times in good districts and probably not more than four or five times in poorer districts.

The Purchase Clause and its Severity.

Now the recent proceedings in Parliament over the London Electric Powers Bills have shown that the terms of the purchase clause are too severe even for wealthy districts, but in the smaller and poorer it is a heavy handicap in addition to other obligations. It is greatly to be desired that for districts below say a certain population or certain rateable value the terms of the concession should be better. If it is not improved it will greatly delay the adoption of lighting in suburban districts and country towns, and in giving them power supply which, while it could be carried out under the Power Acts, would not pay alone.

Length of Procedure.

Again there is the question of procedure under the Provisional Order regulations. When companies apply for orders notice has to be given to the local authorities on the 1st July and the procedure covers a year, the orders being signed usually in May or June of the following year. Thus if the lighting of a district is thought of about Christmas—as is often the case, the desirability of lighting making itself felt about this time—it is necessary to wait eighteen months before an order to proceed can be obtained. The order then comes at a time too late to get plant erected and running by the following winter. Thus it often takes 2 to 2½ years after it has been determined to proceed before an undertaking can get into actual operation, and these long delays and the expenses they occasion take away the incentive to progress, and tire out ordinary commercial men who are accustomed to see some result of their efforts within a year or so.

It is suggested that there is no reason why the Provisional Order procedure should not be assimilated to the light railway procedure which permits application to be made twice in the course of the year.

Foreign Methods of Procedure.

This procedure should be contrasted with that usual abroad, as given for several countries by the lecturer in his paper on overhead transmission before the Institute of Electrical Engineers on February 9th, 1905

In several European countries the procedure is such that if agreement can be come to with the local authorities the whole negotiations need only occupy a few weeks, and in case of disagreement the procedure only occupies three or four months.

Abroad the tendency of legislation is to render private and municipal enterprise mutually helpful. Here, though I believe not intentionally, the result of legislation has been rather to contrast the two and make co-operation difficult.

Conclusion.

In concluding these lectures on Public Power Supply I feel conscious of the fragmentary way in which I have been able to treat a great problem. I have been able to say little or nothing of the application of electric energy to heating, whether in factories, which is having many interesting extensions, or of its use for domestic purposes, a field which is just opening up, or of its probable use in railway working, though the set of figures at which power for these purposes can be supplied may be gathered from the Tables I have given.

However, I think enough has been said to show the magnitude and importance of the supply of electrical energy in the economic, commercial and social life of the future, and my efforts will not have been in vain if what I have said should help to lead our legislators and others to treat the questions which are arising in the working out of this great problem with the attention which it deserves.

THE COAL FIELDS OF TURKEY.

The principal coal fields in Turkey are on the southern Black Sea coast, about one hundred and thirty miles distant from Constantinople, and extend from Heraclea on the west to Filios on the east, a coast line of about forty miles. This coast is precipitous and mountainous, although the maximum height is not more than sixteen hundred feet above the sea level, and is reached at about two and a half miles inland. Near the shore it is not more than two hundred feet above sea level. The whole of these coal-fields are, according to the American Consul-General at Constantinople, Civil List property, permission to work being given only to Ottoman subjects, and even then the Turkish Admiralty reserves the right to purchase sixty per cent. of the amount mined, at a price agreed upon in the mining permit. This sixty per cent. of the total mined can only be sold after having been first offered to the Admiralty, and refused by it. Permits are not transferable without the express sanction of the Government. The Government also claims ten per cent. of the dust. A mine not worked for three months reverts to the Government, which also levies a tax of elevenpence per ton on all coal shipped. This tax can be paid in kind, and the Turkish Government has accepted coal at the rate of ten shillings per ton. The duration of a permit is for no fixed period, but as long as a mine is worked. Some three hundred and ninety-three permits have been delivered up to date, but only about one hundred mines are actually being worked. Permits have been given indiscriminately, and for this reason many were issued at places where it was impossible to work a mine. Some were of no value, and others abandoned owing to the difficulties of transport or lack of capital. The most important of these mines is worked by a French company upon a permit granted to two Ottoman subjects. This company, which has constructed a port and breakwater at Zoungouldak, is the subject of a diplomatic question between the French and Turkish Governments. The French company obtained in the year 1898 from the Turkish Admiralty, which

was at the time of its formation in 1897 entrusted with the administration of these coal-fields, the transfer of the permits to its own name. This transfer was declared illegal by the Sublime Porte, which demanded the re-purchase of these mines. The question has been further complicated by the present company owing to the lack of sufficient capital having influenced the "Régie Générale pour la Construction et Exploitation des Chemins de Fer à Paris," after a year's trial, to undertake the working of its mines from January 1, 1909. This question had every appearance of being settled when the peaceful revolution of July 24, 1908, upset negotiations, and the matter now remains where it was. The output of the Heraclea coal-fields increased from 71,000 tons in 1884 to 625,000 tons in 1907. In ten years from 1884 the output more than doubled, and in the ten years from the formation of the Heraclea Coal Company in 1897 to 1907, it has increased fivefold. This company undertook, when it obtained the transfer of its working permits, to connect the various valleys, Tchatal-Aghazy and Kilimli, with Uzulmes, and Cozlou with Zoungouldak, and also the improvement of the railway line between Cozlou and Kilimli. With this object in view, it has commenced to bore a tunnel between Tchatal-Aghazy and Uzulmes, and on the other side to Kilimli. This work is only about half completed. The company has altogether about ten miles of railway, rolling stock consisting of some 200 trucks and eight locomotives, with which it can handle from four to five thousand tons per day. It has built a port and breakwater, with powerful cranes, and can load between two and three thousand tons per day. Between one hundred and twenty and one hundred and thirty thousand tons of this Black Sea coal are shipped to Constantinople, from twenty to twenty-five thousand tons to Roumania, a considerable quantity to the Ægean Sea, twenty-five thousand tons to Smyrna, and about thirty thousand tons t the Piræus. The company disposes of the largest part of its output to the ships which now coal at Zoungouldak. Besides this well-known coal-field, there are known to exist in Turkey several other fields of importance, but which have never been worked, owing to lack of means of communication and transport. In the same province of Castamouni there is an important field along the coast at Bjide, near Amasra. Three concessions have been granted in this district, but have not been worked for want of capital. At eighteen hours distance from Ineboli there is an anthracite mine, and coal is known to exist in several places in the same district, no attempt being made at working owing to the distance from the sea. In the province of Mamouret-el-Aziz and Diarbekir there are many coal deposits of all qualities, ranging from ordinary lignite to anthracite, but none are worked. In the vilayet of Beyrout there are lignite deposits near the village of Kermaiel, and in the valley of the river Nahr-el Kalb there is a lignite mine yielding five hundred tons, but which is capable of producing ten thousand tons per annum. In the province of Adrianople lignite has been found in the cazas of Dedeagh, Souffli, Ozoum-Keupru, and at Kechan, where a concession has been granted, the preliminary prospecting being found satisfactory, and will now be taken in hand seriously. Permits for prospecting have also been granted for Grisan-Assar, three hours distant from the railway at Xanthi. In the province of Monastir, coal is said to exist in considerable quantities.

THE TRADE OF NICE AND THE RIVIERA.

Nice is such a favourite winter resort for our countrymen, that the recent Foreign Office report on its trade and resources is bound to interest English readers. Its chief commercial asset may be said to be the sunshine of the Alpes Maritimes and Monaco, whence olive oils, celebrated for their purity and fine quality, flowers, and the perfumes of Grasse are exported to the United Kingdom. In respect of oils, though, there has been a falling off, owing to the enforcement of laws against adulteration in France having brought about a great increase of price. As to flowers, during the last two months of 1907 and the first five months of 1908, *i.e.*, from November to May, the total despatched to the United Kingdom from railway stations in the Alpes Maritimes amounted to 2,308 tons in weight; but large as these figures were, there was a falling off, as compared with the figures of the previous year, for two reasons: partly because of the postal authorities having prohibited what used to be the favourite and convenient practice of sending small consignments of flowers to the United Kingdom by post, in sample packets, and partly because the dealers, who send flowers to be disposed of by auction, after arrival in the United Kingdom, are said to have derived little or no profit, and this has had a discouraging effect on florists in the Riviera.

Grasse is said to be, next to Paris, the most important manufactory of perfumes in France. It has been making a brave fight to hold its own against the competition of other countries, particularly Germany, and against the increasing vogue of what may be called chemical perfumes, in contrast to those which are the natural product of flowers. But, in spite of all efforts, the perfumery trade between Grasse and the United Kingdom has sustained a falling off of about 20 per cent. This cannot be attributed to any local cause, but is rather the result of general slackness of trade and widely-diffused depression. Perfumes are luxuries not likely to be much asked for in anxious years. Automobiles are another manufacture in ubiquitous request, and it ought to be possible for British dealers to obtain a larger share than they do at present in the increasing trade of these important aids to locomotion. Seven years ago there were only eight firms dealing in automobiles in Nice; now there

are 45, but not one of the 45 is British or under British management. It is, however, an encouraging fact that whereas French cars were formerly preferred, the United Kingdom is now making up its leeway, and Englishmen in France are using British automobiles. On the water, British motors were still more successful than on land, and at a great competition of motor boats held at Monaco, two British boats were among the winners.

THE AUSTRALIAN MUTTON-BIRD INDUSTRY.

The study of "mutton-birding" is peculiar to many of the small islands about the Tasmanian coast, particularly on the Furneaux group in Bass Straits, where it constitutes the principal means of support of the inhabitants. The "mutton-bird," or sooty petrel, is, when full grown, about the size of the silver gull of North America, and its colour, at first a greyish black, with age becomes a jet black. Their most important breeding places are in the vicinity of Tasmania, and New Zealand; the variety in the latter being somewhat different, and in colour, white, instead of black. The American Consul at Hobart, says that every year, about September 30th, almost to a day, these birds arrive in enormous numbers at their rookeries, and for about a month the male and female birds are busy in restoring their old nests, or in building new ones. When the soil is light and loose the nests are burrowed into the ground close together, but when there is sufficient shrubbery to afford shelter the birds simply deposit their eggs on the bare ground. Frequently large snakes occupy these nests in common with the mutton-birds. As the birds are away at sea in quest of food in the daytime, the nest making is carried on at night. After the nests are prepared, each female lays one egg, which closely resembles a duck egg, and the male and female then take turns at hatching, usually the male bird taking the first turn, while the female goes in search of food, chiefly shrimps, and kelp berries with which she returns each evening. After the lapse of a fortnight, by which time the first sitter has wasted considerably, the partner relieves him, and the male bird will then take upon himself the responsibility of bringing in food. It is not known where the birds go when they leave the islands, about the middle of May. Their flight is extremely swift and irregular, and if the birds strike any obstruction like a rock or the mast of a ship, the collision is usually fatal to them. The lighthouse at Goose Island, one of the Furneaux group, has to be protected with iron screen work, and frequently hundreds of dead birds are found at the base of it. It is only the newly-hatched mutton-birds which have a commercial value, the purposes for which they are taken being for salted human food, for oil (used in tanning leather and for the lubrication of machinery), for the fat used chiefly for greasing timber skids, and for the feathers. The season's work at mutton-birding covers about six weeks, from about April 1 until about the middle of May, when the rookeries are completely deserted. During this six weeks' period, the inhabitants of the islands earn sufficient money to support themselves in practical idleness for the rest of the year. The first stage in mutton-birding is known as oiling. A stick pointed at one end and stuck in the ground at the other serves as a kind of spit or skewer on which to fix the birds as they are caught. Search is then made for the young birds, and as they are caught their necks are broken by a skilful jerk of the hand, and they are then fixed by their beaks to the sticks. It is rather dangerous capturing the birds, as the rookeries are infested with poisonous snakes, and frequently the mutton-birder, when he puts his hand and arm into the hole, lays hold of a snake instead of a bird. When about a couple of hundred birds have been collected, the oil is extracted by squeezing firmly the body of the bird and passing the hand gradually along towards the neck until the oil exudes from the beak. This oil, which is of a reddish colour, has an odour like that of cod-liver oil, and if properly refined it might possibly be used for the same medicinal purposes. There is said to be a number of cases of benefit from mutton-bird diet to persons with pulmonary troubles, anæmia, and other wasting diseases. It takes about one hundred birds to produce one gallon of oil, which sells at from tenpence to one shilling. The next stage in the work is called "fatting," when the birds are first plucked, and then the legs and wings removed; an opening is next made along the back, and the skin with the fat is taken off. The skins, when a considerable number has been obtained, are placed in a large receptacle, and the fat is collected. Next in order is the process of salting. The lower joint of each leg and the outer joint of each wing are thrown away, and the bodies are then salted and packed in barrels in which is placed sea water, and solid brine is then added to make the water still more salt. The birds are then shipped in sailing boats to Launceston, in northern Tasmania, where they sell wholesale at about ten shillings per hundred. About 850,000 birds were shipped to Launceston during last season, and probably about 150,000 birds were retained for the local consumption of the inhabitants of the islands, with whom it is the leading article of food. After reaching Launceston the birds are shipped to other parts of Tasmania, and to Melbourne and Sydney. The market for them appears to be confined exclusively to the Commonwealth of Australia, and chiefly to the mining districts, where fresh food is hard to get, and where the mutton-birds are used as a substitute for salt pork, and a welcome change from tinned meats. The taste for mutton-birds has usually to be acquired, but once people become accustomed to the flavour they seem to grow to like it. The feathers of the mutton-birds, which have a very strong odour, are mostly shipped

to Germany, where, it is understood, a method has been found to rid them of their odour, and render them fit for purposes of bedding. About 25,000 pounds of feathers were exported in 1908, at an average of about three halfpence a pound. About one-half of the inhabitants of the islands where mutton-birding is carried on, are whites, and the remainder half-caste descendants of the aborigines of Tasmania. The mutton-birders are required to pay a Government tax of 10s. for every person above the age of ten years, and half the amount for those under that age, at the beginning of every season. No cattle are permitted upon any Crown lands which are reserved as hunting grounds for the mutton-birds, and taking the eggs of the birds is punishable by fine. Notwithstanding this protection accorded to birds there is indication that their numbers are diminishing year by year, and from four or five of the islands they have already entirely disappeared. The two principal rookeries are at present on Chapel Island and on Babel Island where conditions are most suitable for the burrowing of the birds, and where the best protection has been afforded against depredations by cattle. The number of persons engaged in the industry is about double what it was twenty years ago, and a larger number of birds is taken every year. It is estimated that only about one-third of the young birds escape capture each season on the main rookeries. The Consul states that he has been informed that some of the birds have been shipped alive to Cape Colony, for the purpose, apparently, of ascertaining if they would breed there, but he has obtained no information as to whether the experiment has met with success.

MINES AND QUARRIES.

The General Report on Mines and Quarries for 1908, which has just been issued by the Home Office, contains some interesting information relating to the persons employed in these industries and to the output of minerals.

The total number of persons employed in and about all the mines of the United Kingdom was 1,017,740, of whom 987,813 worked at the 3,338 mines under the Coal Mines Act, and 29,927 at the 721 mines under the Metalliferous Mines Act. Compared with 1907 there is an increase of 47,195 persons at the mines under the Coal Mines Act, and a decrease of 1,675 persons at the mines under the Metalliferous Mines Act. Of the 987,813 persons working at the mines under the Coal Mines Act, 796,329, or 80·6 per cent., were employed below ground. Of the 191,484 surface workers, 6,014, or 3·14 per cent., were females. There is an increase of 364 females as compared with 1907. The number of young persons under 16 employed below ground in these mines was 49,296, or 6·2 per cent. of the underground workers; the total number of surface and underground workers under 16 was 67,435, or 6·83 per cent. of all workers. At the mines under the Metalliferous Mines Act, 17,417 persons, or 58 per cent., worked below ground, and of the 12,510 surface workers, 211, or 1·69 per cent., were females. At the quarries under the Quarries Act there were 85,475 persons employed, of whom 54,449 worked inside the actual pits or excavations, and 31,026 outside. Compared with 1907 there is a decrease of 1,445 among the inside workers, and of 894 among the outside workers, making a total decrease of 2,339 in the number of persons employed at quarries. The persons employed occasionally at quarries are not included in the above figures.

The total output of minerals at the mines under the Coal Mines Act was 275,540,746 tons, of which 261,512,214 were coal, 2,814,411 fireclay, 7,890,814 ironstone, 2,891,564 oil-shale, and 431,743 sundry minerals. Adding 16,581 tons from open quarries, the total output of coal was 261,528,795 tons, which is a decrease of 6,302,167 tons on that of the previous year. The average output of mineral at mines under the Coal Mines Act was 346 tons per person employed underground, a decrease of 26 tons on the preceding year. The total output of minerals at the mines under the Metalliferous Mines Act was 3,128,230 tons, of which 1,549,469 tons were iron ore. The total quantity of stone and other minerals obtained from the quarries under the Quarries Act was 44,732,016 tons, of which 4,801,561 tons were iron ore. Adding to the produce of mines and of quarries over 20 feet deep 789,181 tons obtained from shallow open workings, we arrive at a total output of iron ore of 15,031,025 tons.

THE FIG INDUSTRY OF SMYRNA.

The 1908 production of Smyrna figs has been estimated at about 30 per cent. less than the usual crop, but the quality is exceptionally good, although the size of the fruit is small. Merchants during the year 1908 worked under less restrictions, as far as the importation of the figs into the city of Smyrna from the interior of the country was concerned, than in former years. This restriction in the past has consisted chiefly in the attempt to regulate the number of figs to reach the market, in order to keep prices as high and uniform as possible. The American Consul at Smyrna says that such obstacles have never been placed upon any other product entering Smyrna from the interior of the country. The practice was keenly felt, for the reason that figs packed in two-hundredweight bags, arriving on the market for sale, could not be kept for more than two days, and for every succeeding day they were detained the quality deteriorated about 10 per cent., while their value and available price naturally dropped in proportion. Figs are one of the most important products grown in Asia Minor, and their handling and packing give employment to many thousands of men and women during three or four months of each year. The celebrated fig district in the vilayet of Smyrna is the region about the town of Aidin, on the Smyrna-

Aidin Railway. Fig trees begin to bear fruit in the sixth year, and gradually attain their best period about the tenth year. The trees grown on the Meander plains produce a larger and richer fruit than those nearer the sea or in the uplands in the neighbourhood of Smyrna. This is the case, however, only in normally dry seasons, as too much moisture harms figs, therefore, in off years, or flood years as they are termed in Smyrna, the trees in elevated regions yield a superior fruit to those situated in the lowlands. The wet season highland fig, however, can never attain the delicious taste of a fig which ripens in the plain during a dry season. Figs, as a rule, ripen about the first of August. They fall to the ground after full maturity, are permitted to dry in the sun for a period of six days, after which they are packed into sacks weighing, when full, two hundred and fifty pounds each. One feature of fig-growing which is especially interesting and peculiar is that concerning the male and female figs. Visiting the fig market in the town of Aidin during the month of June, Turkish peasant women from the country were seen engaged in selling only male figs in little baskets. Crawling over the figs were many insects, and upon one of the figs being broken open it was found alive with these insects, which began escaping in every direction. These male figs are purchased by fig-growers in the Smyrna market and hung in bunches on the branches of female fig trees near the growing fruit, which is still very green in the month of June, and about the size of a walnut. The insects from the male figs rapidly collect on the female fig, penetrate the thick skin, and fertilise the fruit. When left in their natural state the process of fecundation is much slower than when thus assisted by hanging a bunch of male figs upon the branches of a female tree. The fruit of a male fig tree is never eaten, and the moment the insects leave, it withers away and rots. In transporting figs to the Smyrna market the greatest care is taken not to bruise the fruit. Sacks are never packed one upon the other. From the orchards in the interior, these sacks are transported upon the backs of camels to the nearest railway station. There are wagons specially built for the fruit, with shelves one above the other, so there is absolutely no danger of pressure or jolting. From the Caravan Bridge railway station at Smyrna they are again transported by camels to the bazaars. The sorting of figs is carried out with the greatest care. They are packed in jars and boxes according to the thickness of the skin and the general size of the fruit. The inferior grades, or the "Hordas," which are little better than refuse, are eliminated from the better qualities and used for distilling purposes. Sometimes figs of this kind are used as a substitute for the chicory root. Although the 1908 fig season, on the whole, was a good one, yet it is doubtful if it was a satisfactory one from a financial point of view, and this applies more especially to the working classes, who in former years made enough money in the three to four months' packing season to live throughout the winter.

ARTS AND CRAFTS.

The New Victoria and Albert Museum.—The opening of the new building of the Victoria and Albert Museum is an event the importance of which, from the point of view of art and craftsmanship, can hardly be over-estimated. A whole generation has grown up grumbling at the arrangement or want of arrangement at South Kensington Museum. If we may judge by what has already been done, when once the collections are arranged in their new home there will be no real cause for complaint. The fact is, that for longer than most of us can remember the Museum has been suffering from an *embarras de richesses* so great that many of its treasures could not be shown, and that the objects on view were so tightly packed together that it was almost impossible to see them. This was particularly evident with regard to the glass and the textiles, where the cases were so close to each other that it was quite difficult to squeeze in between them and go from one to another. One constantly felt, in visiting newer museums on the Continent, that the superiority of their arrangement was due not so much to, say, a German talent for classification, as to the comparative simplicity of the problem which the directors had to face. It is one thing to arrange a small number of objects to the best possible advantage in a new and spacious building, it is quite another and a more difficult matter to show a vast quantity of things in a building far too small to accommodate them properly.

It is, of course, too early to speak confidently of the minor details connected with the arrangement of the new museum. Some of the halls are not yet filled, the new special wall-cases have not arrived, and a few of the rooms have obviously been hastily and only temporarily arranged. But the main plan of the classification is clear. The museum has been systematically arranged with a view, primarily, to the needs of the artist, the craftsman, and the serious student. There is much in it to interest the man in the street, but it is not to him that, in the first instance, it makes its appeal.

The collections are grouped according to industries, such as woodwork, furniture and leather; metalwork; textiles; ceramics, glass and enamels; so that students can conveniently study any special branch of work as a whole, and find examples of the particular technique in which they happen to be interested. This system of classification had, of course, been followed more or less in the old building, but not nearly so wholeheartedly as in the new museum, and the logical completeness of the arrangement is very considerably increased by the inclusion of examples of Eastern handiwork. For some reason or other the India Museum (so called though it embraced Oriental work generally) has always been comparatively little visited, and the inclusion in it of all Eastern work, whether from India, China, Japan, or elsewhere in Asia, not only kept some of our greatest treasures housed in a separate and less-frequented building, but encouraged

the idea that Eastern and Western art were two not merely distinct but totally different things. It is to be hoped that the greater facilities for study in the new building will encourage students of art and handicraft to use the Museum at South Kensington to a far greater extent than they have done heretofore, and that the opportunity of studying European and Eastern work side by side will prove an aid to the appreciation of the unity of art, as well as a lesson in comparative technique. The Indian collection proper, it should be said, seems, in deference to a popular outcry, to have been left in the old galleries on the other side of Exhibition-road.

Craft Work by London County Council Scholars.—The annual show of work by winners of the various scholarships and exhibitions offered by the London County Council for proficiency or promise in art and craftsmanship, took place at the Central School of Arts and Crafts for a couple of days in the middle of the month, and proved one of the most interesting exhibitions of the kind that has been held for many years. It is not that the exhibits are by any means uniformly excellent, though some of them are very good indeed, but that they show so well the general trend of art and craft teaching in London at the present time. This being so, it is not surprising to find that a good deal more attention is being given to certain crafts and, incidentally, to the kind of design in which the worker in them needs to be versed than to pattern design for manufacture. Very little pattern, comparatively, was shown, and not many of the designs were satisfactory. They evinced, moreover, a tendency to imitate Morris in a way more suggestive of parody than of flattery. On the other hand, the woodwork generally, and some of the bookbindings showed a sense of form and a taste which were quite refreshing. Very little carving was shown, and that little was not displayed to advantage, but the simple inlay and cabinet work generally were all that could be desired, and more than could be expected in the matter both of treatment and of accomplishment. Indeed, most of the pieces of furniture on view were such as one would have been only too glad to have seen in one's own house—practical without being cumbersome, and simple without being affected. It is to be hoped that students trained in the technical school to do work like this will have an appreciable influence on the output of their trade.

Amongst the bookcovers there was a small amount of half-binding and other plain work, but they ran, on the whole, to rather elaborate ornamentation. Students in these bookbinding classes no longer design all after one pattern, as though they had all studied under the same master, as they did some years ago. In some cases they have departed from the dignified simplicity which marked this work at its best without arriving at anything better, or, indeed, as satisfactory; but, on the whole, in spite of some blunders in taste, the work is more vigorous and more convincing, more individual one might even say, than it used to be. Some of the script exhibited was beautiful, though students badly want a little drilling in the way to divide their words. *Wal* in one line and *ked* in another, for example, is a division of the word "walked" which ought not to occur in an elaborately illuminated page. There was some good, bold lettering of the sign-writing type, which showed a very marked improvement on the performance of a year or two ago.

Embroidery is always amongst the crafts most largely represented — and in it, too, considerable advance has been made. Not only have the rather trifling little sprig patterns which were the rule given place to quite dainty, though still quite simple, connected pattern, but the general level of technical accomplishment is decidedly higher than it used to be. The prevailing fashion in dress has been eagerly hailed by the schools as affording a chance for the employment of embroidery in connection with dressmaking—and with very happy results.

The exhibition included a certain amount of competent metal-work, though there was less jewellery and enamel-work than we have been accustomed to see. Perhaps the enormous output of more or less artistic jewellery in recent years, and the very low price at which much of it is sold, may, in a measure, account for the falling off.

Taken as a whole, the show marks a decided advance on the part of the schools working in connection with the London County Council.

Fireplaces, &c., at the Agricultural Hall—The Ironmongery and Hardware Exhibition has not, on the whole, very much to do with art. It was rather interesting to note that safes, now-a-days, are enamelled in quite artistic colours, though there has been very little improvement in the colour of the ordinary hot-water can. This last is generally of the yellowish-brown (in imitation of oak graining), with which we have all been familiar from our youth up, and when it is not, it is painted in so-called art shades of a singularly unattractive type. Again, certain by no means beautiful coal boxes, with lids ornamented with blobs of brilliant-coloured enamel, show a lingering remnant of the craze for decorating anything and everything with enamel. But the real interest in the show at the Agricultural Hall from the point of view of industrial art lies in the opportunity of seeing what is being done in the way of grates and fireplaces and the like. And, the scope of the exhibition being commercial rather than artistic, it shows what is normally on the market rather than what can on occasion be achieved. It is, therefore, very satisfactory to see how great has been the improvement in the appearance of the ordinary fireplace in the last couple of years. To begin with, the actual metal-work is much simpler, and in so far, much better than it used to be. There is an absence of the florid cast ornament which used to form a feature of the dining-room grate; and the hoods rendered necessary by the

principles on which modern grates are constructed are far simpler and more graceful in shape than they were a few years back. One very simple, rather Georgian-looking grate was shown by the Bell Foundry Company. Though very plain in design, it was striking on account of the excellence of its proportions. The shape and character of the grates has, naturally, its effect upon the accessories, and the old-fashioned made-up tile surround seems to be yielding either to simple metal sides or to tile panels of "Adams" or such-like patterns, designed especially for their places. The wooden or other mantelpieces surrounding the grates, if not on the whole very remarkable, are at least an improvement on the ornate erections which were so long the fashion.

QUESTIONS AND ANSWERS.

Readers in search of information which cannot be obtained from the usual sources are invited to make their wants known in the *Journal*, in the hope that they may be assisted in their difficulties by their fellow members.

On all communications must be written the name and address of the sender, not necessarily for publication, but as a guarantee of good faith.

Each question or reply should be written on a separate sheet of paper, and should bear such signature of the writer, and such address as he wishes to appear.

Questions which can be answered from the usual books of reference, will not be printed.

QUESTIONS.

BLEACHING STRAW FOR HATS.—Can any of your readers enlighten me as to best method of bleaching white straw plait? The plait I wish to bleach is from the Palmyra palm leaf. Sulphur does some good, but there are processes in England which are a secret, a certain chemical being used.—CHITTAGONG.

COPRA.—A large quantity of the copra exported to Europe arrives at its destination covered with mould. Is there any treatment by which this can be obviated?—MALAY.

GENERAL NOTES.

MEMORIAL TABLET.—The London County Council have recently affixed to No. 4, Beaumont-street, W., a memorial tablet bearing the inscription:—"John Richard Green, 1837-1883, Historian of the English People, lived here." During the three-and-twenty years which elapsed between his first acceptance of a curacy at St. Barnabas, King-square, Goswell-road, and his death in 1883, John Richard Green occupied numerous residences in London, but the house in Beaumont-street was his home for the longest period, and it was here that he wrote the "Short History of the English People."

INTERNATIONAL FOOD CONGRESS.—The second International Food Congress will be held, under the auspices of the Society of the White Cross of Geneva, in Paris, from October 17th to 24th. The first Congress was held last year at Geneva, and was devoted mainly to definitions of food and alimentary substances. It was well attended, the number of delegates from the 29 countries represented being 400. This year the principal work of the Congress will be to consider the operations and manipulations permissible in connection with food substances, with a view to the repression of adulteration in food, chemical products, drugs, mineral waters, &c., and it is already certain that the number of delegates representing Governments, local authorities and associations will be far larger than that which attended the Congress in 1908. The Society of the White Cross of Geneva was founded last year with the primary object of grouping together by means of international organisation, the efforts being put forth in various countries for the amelioration of social conditions.

TINNING OF METALS.—A Parliamentary paper (Cd. 4740), which has just been issued, contains the draft regulations proposed to be made by the Home Office for factories and workshops in which tinning of metal articles is carried on. They provide that tinning shall be performed under an efficient draught; that no person under 16 years of age shall be employed in tinning; that skimmings from the dipping bath shall not be removed from under the efficient draught until they have been placed in a covered receptacle; and that these, as well as the dust and refuse collected from the floor, shall not be deposited in any room in which work is carried on. A health register containing the names of all persons employed in tinning is to be kept, and every person employed will be examined periodically by a surgeon, who shall have the power of suspension. A cloak-room must be provided for women workers (as well as aprons or other equivalent protection), and a meal-room and a lavatory must be maintained at every tinning works. It is also provided that all persons employed shall wash their hands before partaking of food or leaving the premises, and that no food or alcoholic drink shall be partaken of in any workroom. The regulations will not apply to any process in silver plating, or any process in which a soldering iron is used, or to any other process which may be exempted by the Chief Inspector of Factories on the ground that the regulations are not required. The regulations will come into force on October [illegible] next, except the one relating to the carrying on of tinning under an efficient draught. This will come into operation on April 1 next.

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

MODERN METHODS OF ARTIFICIAL ILLUMINATION.

By Leon Gaster, A.M.I.E.E.
(Editor of the *Illuminating Engineer.*)

PART I.*

Introduction.

When I consider the long list of distinguished predecessors who have delivered Cantor lectures before the Society, I need hardly say that I greatly appreciate the honour and privilege of delivering this series on "Modern Methods of Artificial Illumination."

It is, I think, peculiarly fitting that the Royal Society of Arts should take an interest in this subject, for it may truly be said that, in the past, they have encouraged the development and utilisation of all illuminants in an impartial manner such as, perhaps, no other Society in this country can claim to have done. They have invariably presented an opportunity for the discussion of all methods of lighting from the candle to the glow lamp, and many years ago they had already offered prizes for the invention of miners' lamps, lighthouse apparatus, and other practical developments in lighting. Over 100 papers have already been read before the Society dealing with various aspects of the subject with which I am concerned in these lectures.

As early as 1874 Cantor lectures were delivered by Prof. Barff, M.A., on carbon for heating and illuminating purposes. Again, in 1881, Prof. W. Grylls Adams, F.R.S., delivered Cantor lectures on the scientific principles involved in electric lighting, while in 1883 Mr. Leopold Field, F.C.S., lectured on solid and liquid illuminating agents.

The Cantor lectures by Prof. Vivian Lewis on acetylene, and also on the theory of the incandescent mantle, &c., undertaken at a time when these subjects had begun to interest the general public, and Prof. Sylvanus Thompson's exhaustive Cantor lectures on "Arc Lamps," are again illustrations of the enterprising and impartial policy of the Society.

In 1881, Dr. R. Brudenell Carter delivered a series of Cantor lectures on the subject of colour blindness. In that lecture, and in the subsequent valuable communications of the same author on the subject of eyesight, indications are furnished that the Society was early alive to the importance of drawing attention to the preservation of the eyesight of the public, and its important connection with good illumination.

Naturally, in the short time at my disposal, I cannot hope to deal exhaustively with each special department of the subject of illumination so as to furnish information to the expert in his particular line; my aim and object will be rather to cover the ground in a general manner, and to show how it is possible to take an impartial interest in all systems of lighting, and to emphasise the true merits of each illuminant for different purposes.

I may, however, preface my discussion of this subject by a few remarks on the development of illumination in general. The introduction of gas for street lighting for instance, dates from about 100 years ago. Previous to this time we had recourse to oil lamps, and it is even said that bowls of pitch were used to light the streets of Paris in the sixteenth century.

At the same time the use of lamps for interior lighting was likewise in a very primitive state. In those days the expression "The night when no man can work" had a very real significance which we can hardly conceive to-day. Now, in the present age, the tendency is to do more and

* The Course consisted of four lectures, delivered on February 15th and 22nd, and March 1st and 8th. In re-arranging the material for publication in the *Journal*, the lecturer has preferred to divide it into six parts.

more work by artificial light and to turn night into day with an ease our forefathers might or might not have envied, but certainly would have regarded as incredible. Step by step with these developments in lighting have taken place the progress of education and the spread of printed matter, until, to-day, we use our eyes for the purpose of acquiring knowledge to a far greater extent than in the times when neither education nor adequate illumination was generally available.

In the same way the eye is used to a far greater extent in education than was previously the case. No lecture is now considered complete without the exhibition of a few lantern slides, while recently such special appliances as the cinematograph have also been put to the service of education.

We ought, therefore, obviously to consider not only the actual light we produce but its effect under practical conditions—the actual illumination in which we are mainly interested, and for which we are really paying. Expressing the matter epigrammatically we may say "light is the cause, and illumination the effect."

I dwell on these points but briefly in this present lecture, meaning to return to them in greater detail later on, but I would ask you to bear the situation in mind when I go on to mention some other developments in the quality of lighting that have given rise to important changes in industrial conditions. Viewed from this aspect we are bound to realise that illumination is first and last dependent on the physiological impressions from the eye. Into this point, too, I do not wish to enter too closely in the present lecture; it seems, however, a little singular that this obvious fact has not hitherto been very generally realised among engineers, who are at the present time mainly responsible for the generation and distribution of light.

Simultaneously with this enormous progress in the amount of light available has proceeded a remarkable development in our powers of modifying its quality.

Returning to our earlier sources—the camp fire and the charcoal brasier—we see that the light thus obtained was of a distinctly reddish character; afterwards came the pine torches, still very red, then candles and oil lamps, which are whiter. Later still the introduction of gas provided light of a still lighter tint, and, indeed, we have records of objections to it on this score when it was first introduced. The incandescent mantle and the electric light have now provided sources of light that are whiter still.

Now this change in colour corresponds with a very natural development in the temperature of incandescence obtainable, for all the sources named depend for their action on the heating up of solid particles. In civilisation we have passed through a similar process to that which takes place when we heat up a piece of iron. At first we merely obtain a jumble of radiations of long wave lengths, none of them capable of giving rise to the succession of light. As we go on heating we eventually perceive a faint red glow corresponding to the low vibrations, and then this glow develops a yellowish and eventually even a whitish character.

Yet we know that by heating solids in this way, we must always obtain only a confused forced vibration of the mass as a whole, and therefore relatively few rays of the luminous variety. Still more recently, however, we have learned how to employ luminescent gases in which the natural frequency of vibration of the different particles is utilised so that we obtain only vibrations of certain specified frequency, and a corresponding peculiarity in colour, certain rays being often absent, which exist in the normal spectrum of an incandescent solid. An illustration of such methods is afforded by the mercury vapour lamp and the flame arc.

These I mention, merely in order that you may bear in mind that the change in methods of illumination, to which we are now becoming accustomed, is one not only of quantity, but also of quality, and therefore requires correspondingly careful study, in order that we may know how the new conditions may be utilised to the best advantage.

After this preamble, I may now turn to the consideration of recent developments in electric lighting, and I think that a fitting introduction to these new illuminants is provided by the following abstract of Mr. Swinburne's Presidential address before the Institution of Electrical Engineers in 1902:—

"Our chief work, until lately, has been producing light. Here the inefficiency and waste is prodigious, there is still great room for improvement. We take great care over our stations, watching every penny from the coal shovel or mechanical stoker to the station meter. We quarrel over 1 per cent. in the generators. When we get to the mains we care less, and once we get to the customers' meters we care nothing at all."

Since the date of Mr. Swinburne's address we have seen a wonderful development in electrical illuminants. We have seen great

progress in Flame Arcs, Metallic Filament lamps, not to mention the Mercury Vapour lamps, and the Moore Vapour tube.

We have also seen a great change in the method of regarding the utilisation of the light we have been at such pains to produce, and the partial realisation of the true significance of the word "Illumination." As an amusing illustration of this fact let me mention the experience of a friend who had the curiosity to look up the word "illumination" in an encyclopædia. He was rewarded by the cryptic reference, "Illumination—see fireworks."

GLOW LAMPS.

It may seem strange to reflect that from about the year 1878, when the first practical incandescent lamps were introduced, until a few years ago, when metallic filament lamps came upon the scene, the actual construction of the carbon filament lamp should have remained so essentially the same. Yet we must remember that there were wide gaps in our knowledge of the materials available for the manufacture of the filaments of these lamps which have since been utilised so successfully; these gaps had to be bridged before the newer material could be turned to practical account.

In addition, as M. Blondel has shrewdly remarked, there were several misconceptions which inventors did not learn to avoid. It was, for instance, generally supposed that all that was necessary was to find a substance with a very high melting point, and therefore capable of being carried to a very high temperature of incandescence. Actually we know now that this is a desirable quality in filaments, but at the same time we also know that the carbon tends to vapourise at temperatures very far below that at which it actually melts, and it is this tendency which imposes a practical limit on our possible temperature.

By bringing a carbon filament lamp to incandescence at a voltage higher than that at which it was intended, we could obtain a corresponding increase in efficiency, but only at the cost of its durability and life—long before the melting point is reached the volatisation of the carbon sets in and brings the filament to a premature end. What was really wanted, therefore, was a material that only began to vapourise in this way, and therefore to disintegrate at a temperature above that utilised in the carbon filament lamp.

Nernst Lamp. — Regarding the Nernst lamp, which deserves the credit of being one of the earliest commercial attempts to increase the efficiency of incandescent lamps to any great extent (being introduced about 1897), I have not at my disposal any very novel data which can be made public. It may be said, however, that experiments are in progress with the object of making the filament in such a way as to enable it to "light up" more quickly without the necessity of the inconvenient heating coil and its additional complications.

The Electrical Company have now put on the market an improved form of Nernst lamp of specially small design, in which the four parts of the original Nernst lamp, namely, the body, burner, resistance, and globe are now combined into one unit.

The 220 volt lamp is stated to yield 30 candle-power and to consume abont 0·2 ampères, the efficiency being thus about 1·4 watts per candle. Improvements in manufacture enable the lamp to light up in, approximately, 10 to 15 seconds after switching on the current, and the life of individual lamps under normal conditions is stated to be not less than 400 hours. The average life of a burner has, however, been found to exceed 700 hours. I understand that the company undertake to replace free of charge any lamps which are burnt out under the specific period of 400 hours. The lamp is manufactured for all voltages from 200 to 300, but for the present they are only recommended to be used on direct current circuits.

By the kindness of the Electrical Company, however, I am also able to show you to-night one of the most recent developments in these lamps, namely, a 200 volt, 1,000 candle-power lamp utilising three glowers.

The Osmium Lamp, introduced about 1898 by Auer von Welsbach, to whom we also owe the incandescent mantle, is interesting as being one of the first of the commercial metallic filament lamps of recent date. There were, however, many difficulties in its manufacture—notably its brittleness, and the inability to make lamps for higher pressures than 50 volts—which hindered its development, and the lamps have been practically superseded by others to-day.

Filaments of *iridium*, a kindred metal, have been constructed by Gülcher. Here again, however, it seems to have been found very difficult to make lamps for reasonably high pressures, and the use of such filaments seems to be confined to low voltage lamps for accumulators on motor vehicles, &c.

The Tantalum Lamp, as you know, consists of drawn wire composed of the metal Tantalum.

The consumption of the lamps now on the market, of which you will see some illustrations (kindly supplied by Messrs. Siemens and Co., Ltd.), varies from about 1·8 to 2·2 watts by candle.

To this Company also belongs the credit of having produced a 16 candle-power metallic filament lamp working at 100 to 130 volts, and a 32 C.P. lamp on 200-250 volts. I am given to understand that still further developments will follow shortly. The useful life of the lamp under normal conditions can be taken as about 800 hours. I will refer, in a later part of this lecture, to the behaviour of Tantalum filaments on alternating currents circuits.

There have, however, not been wanting experiments having for their object the improvement of the carbon filament lamp.

Graphitised Filaments.—You are probably acquainted with the researches of Mr. Howell in the United States (Proc. Am. I. E. E. 24, p. 617, 1905) who by a special process succeeded in making a so-called graphitised filament capable of giving a satisfactory light at a consumption of 3 watts per candle. The behaviour of these filaments suggests that we are dealing with an allotropic form of carbon in which it approximates to the qualities of a metal having a positive temperature co-efficient under normal conditions. Had it not been for the immense development of the more efficient metallic lamps, this marked advance would have received more attention than it actually has done.

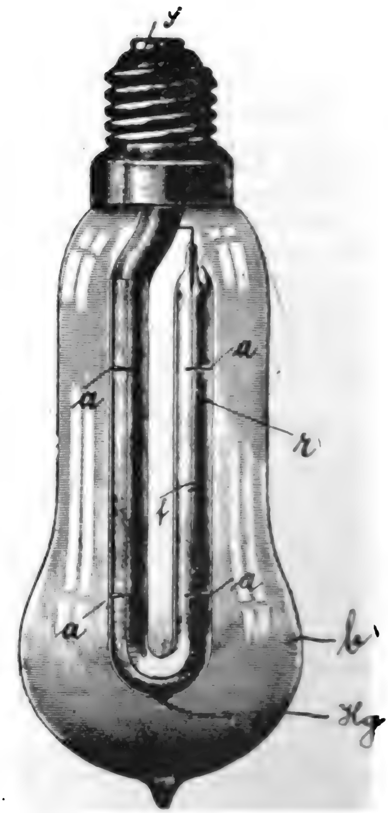
Filaments of Soot, special Carbon Filaments, &c. — Experiments in this direction are still proceeding, and I observe that two German inventors claim to have succeeded in making a peculiarly homogeneous carbon filament from soot produced by the carbonisation of vegetable oils, and also from the materials used in Chinese ink. For this filament a useful life of 1,000 hours with an efficiency of 1 watt per candle (Hefner) is claimed.

The Hopfelt Lamp.—Another interesting attempt to run carbon filaments at an increased efficiency is due to Hopfelt (E.T.Z., Oct. 8th, 1908, *Illuminating Engineer*, vol 1, p. 631) who has utilised a carbon filament burning in an atmosphere of mercury vapour. It is claimed that the high pressure of the latter reduces the tendency to disintegration on the part of the filament, and therefore enables us to run at a consumption in the neighbourhood of 1·5 watts per candle.

It is too early to speak of the possible developments of this method. I have, however, a few here on exhibition in order that you may judge for yourselves.

Since writing the above I observe that a more complete study of this lamp has been published by U. Bordoni ("Atti della Assoc. Ellettrotecnica Italiania," March-April). He, however, describes researches according to which the lamps examined had but a small life.

FIG. 1.



HOPFELT MERCURY-CARBON GLOW LAMP.
f, filament; *a, a, a*, supports for filament; *Hg*, globule of mercury; *b*, outer bulb; *r*, inner tube containing filament.

The Helion Lamp.—An interesting type of lamp is that brought out by Parker and Clark in the United States, termed the "Helion" lamp.

The filament of this lamp is supposed to consist mainly of silicon, which is deposited by a special method on a carbon core. M. Blondel has advanced the suggestion that this may form an eutectic alloy with the carbon (Congrès de Marseille, 1908).

For this lamp it is claimed that a life of over 1,000 hours, at an efficiency of one watt per candle-power, coupled with practically no

diminution in intensity is obtained; at the same time all the advantages of a high resistance filament are said to be secured. More recently still, the inventors claim to have improved the filament sufficiently to enable it to be burned in the ordinary atmospere without any vacuum; they also state that it can be overrun to a very considerable extent without suffering thereby. (*Electrical World*, N.Y., September 5, 1908). In spite of the excellent results recorded, however, we are still waiting for these lamps to be put upon the market on a commercial scale.

Tungsten Lamps. — There are now very many forms of Tungsten lamps on the market. They are called by different names and made by several distinct processes, but although the actual materials are believed to be subject to a slight modification in the case of different firms. it seems to be generally agreed that the metal tungsten is the basis of their composition. The actual processes of their manufacture are, however, extremely complicated, and I cannot hope to attempt to describe them on this occasion.

I should, however, like to refer to those who desire more complete details to a recent paper by M. Blondel (Congrès de Marseille, 1908) and to articles by Dr. H. Weber and Dr. Jacobsohn (*Illuminating Engineer*, London, vol. i., pages 297, 395, 463), in which some very complete data are given. It may, however, be said that there are at least three distinct chief processes. According to the first the metal is reduced to an "impalpable" powder, mixed with some adhesive binding material, and squirted through a very fine die. Subsequently all traces of the foreign binding material are very carefully removed, leaving only the pure metal, the filament being also brought, by a special process, from the non-conducting into the conducting state.

It is wonderful that such good results should have already been accomplished when we consider that filaments so made really consist of a collection of fine disjointed particles fused together.

Another process consists in the deposition of tungsten upon a carbon filament which is brought about by incandescence in an atmosphere of volatile tungsten compounds so that the tungsten gradually replaces the carbon; subsequently by special processes, the last traces of carbon are removed.

Yet another process is the well-known colloidal process of Kuzel, according to which metals are reduced to a special gelatinous condition, such that they can be squirted into filaments without the admixture of a binding material; in this way the arduous process of subsequently removing all traces of impurity introduced are avoided. These lamps have been sold in Vienna under the name of "Sirius," and are to-day sold in London by Messrs. Falk, Stadelmann and Co., Ltd., as the "Sirius-Effesca" lamp.

Although we must admit that most of these methods originated in Germany and Austria, we can comfort ourselves with the reflection that much of the early pioneer work of electrical glow lamps was carried out in London. At the present day too, I am happy to state that the manufacture of these lamps is being taken up in the country. To-night there are on exhibition different types of metallic filament lamps as supplied by Messrs. Boddy and Co. (the Metallik), The Bryant Trading Syndicate, The British Thomson-Houston Co., The Edison and Swan United Electric Light Co., The Electrical Co. (Aegma), Messrs. Falk and Stadelmann, Ltd. (Sirius-Effesca), the General Electric Co. (Osram), The Stearn Electric Co., The Sunbeam, the Westinghouse Co., and the "Z" Electrical Syndicate. Lamps are also sold under the following names, among others, in this country: — Simplex, Meta, Empire, E.M.F., Gral, Z., Auriga, Metfil, Tangent, Metalite, Rugby, Gabriel, Solium, Omega, &c. This will serve to furnish some idea of the choice of lamps available, some of which are now manufactured entirely in this country.

Some qualities of the metal filament lamps of interest are those given by Remané ("Verb. Deutsch. Elektrot.," 1908), and by Satori in a recent article in the *Illuminating Engineer* (Vol. II., p. 386).

As you will understand from these curves (see Fig. 2), there is no physical impossibility in obtaininga consumption of even less than 1 watt per candle-power from the ordinary carbon filament; but you will also observe how rapidly its life is decreased by doing so. The same holds good for the Tungsten lamp, as this diagram clearly shows. It is, however, worth knowing that now that carbon filament lamps are so cheap compared with the most efficient metallic ones, it may sometimes be advisable to overrun them intentionally at, say, 2·5 watts per candle, so as to obtain a higher efficiency, even coupled with a loss of life. This point has been dwelt upon by the correspondent of the *Illuminating Engineer* (Vol. I., December, 1908, Vol. II., January and February, 1909).

But let us ask ourselves what disadvantages the new lamps already possess, and what prospects of improvement we see before us. In reality, when one follows closely the immense technical difficulties with which the manufacturers of metallic filament lamps have been confronted, one can only marvel at the ingenuity with which they have overcome obstacle after obstacle. One of the main problems has been, and is still, the production of a metallic filment lamp of high voltage and low candle-power.

Thus the production of a Tantalum 220 volt 50 candle-power lamp is said to involve the use of wire of a diameter of only 0·04 m/m, and it is a miracle of ingenuity to draw homogeneous wire so fine. Yet Tantalum 250 volt 32 candle-power lamps are already on the market.

An Osram 220 volt 50 candle-power lamp involves a filament of the same order of diameter, coupled in both cases with an extraordinary length of filament.

Several lamp makers now announce that they are in a position to supply 200-260 volt lamps of as low a candle-power as 25-30 candles.

In the United States a 25 watt 100 volt Tungsten lamp has already been produced. As an illustration of the difficulty of this process I may mention that it takes a man a week's careful work even to make the die through which such filaments are forced.

FIG. 2.

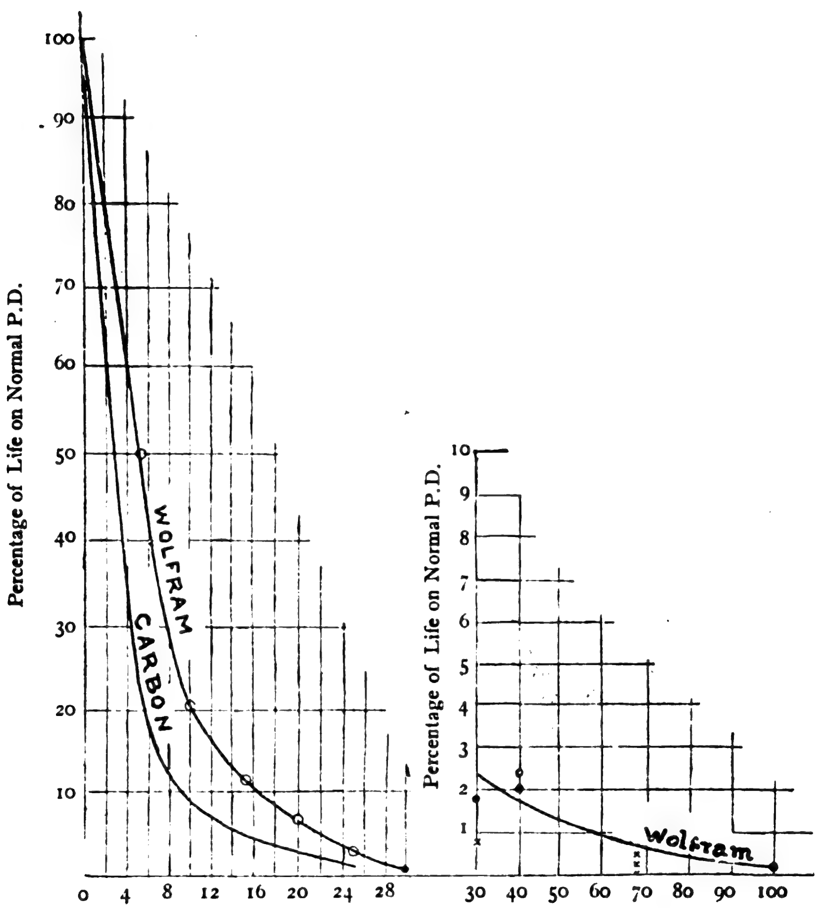


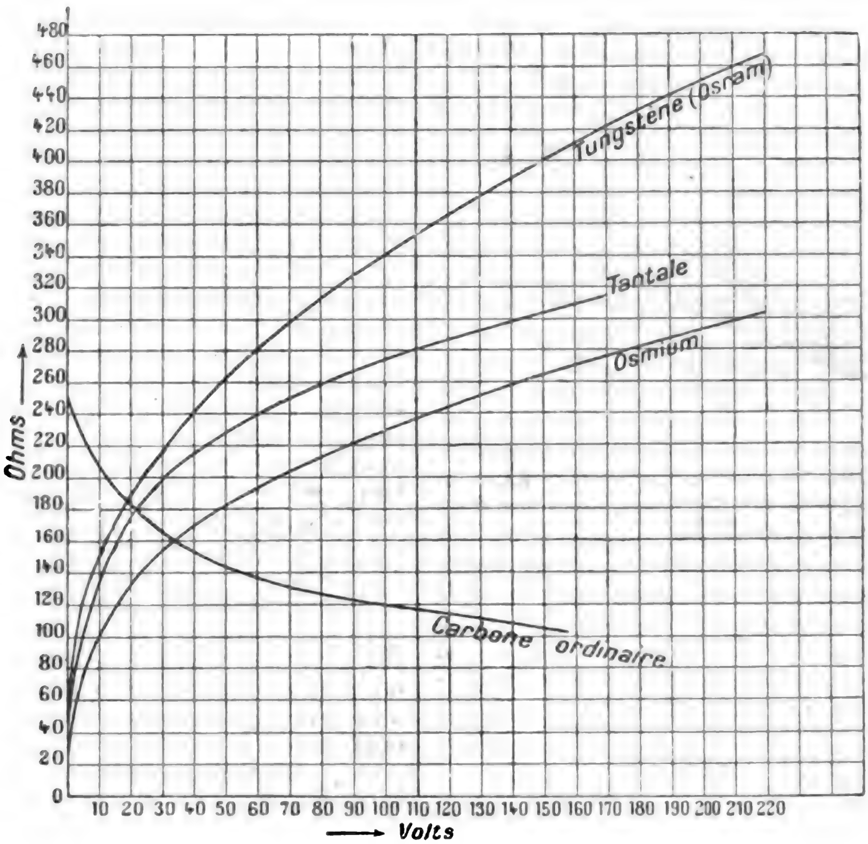
DIAGRAM ILLUSTRATING EFFECT ON LIFE OF OVERRUNNING CARBON AND TUNGSTEN FILAMENT LAMPS. (Satori, *Illum. Eng.*, London, Vol. II. June, p. 386.)

Since the delivery of this lecture I notice that several makers have already brought into the market 16 candle-power, 100-130 volts metallic filament lamps rated at a consumption between 1 and 1½ watts per candle. Indeed, within the last few weeks the announcement

has been made that the Stearn Co. are producing a 200 volt, 16 candle-power, 25 watt lamp. Simultaneously with the improvement in this respect a great reduction in the price has also taken place. I cannot help feeling, as I have already previously pointed out, that it would have been far better if manufacturers devoted their efforts to improving the lamps they have already put on the market, instead of expending misplaced energy in cutting now about the same size as those of carbon filament lamps, so that the original fittings and shades can be used upon replacing carbon lamps by these new types.

The difficulty in making high voltage low candle-power metallic filament lamps rests, of course, mainly in the very low resistance of the filaments compared with carbon. Yet, from one point of view this defect may be regarded as fortunate because of the extremely disturbing

FIG. 3.



CONNECTION BETWEEN RESISTANCE AND PRESSURE OF CARBON FILAMENT TANTALUM, OSMIUM, AND TUNGSTEN LAMPS. (Blondel, Congrès de Marseille, 1908.)

one another's prices. If by the united action of lamp makers and dealers the prices were kept at a steady figure, giving a substantial margin of profit, funds would then be available for adequate experiments with the object of improving the quality of lamps. Progress will naturally be hindered by forcing the pace and supplying an indifferent article simply to meet competition.

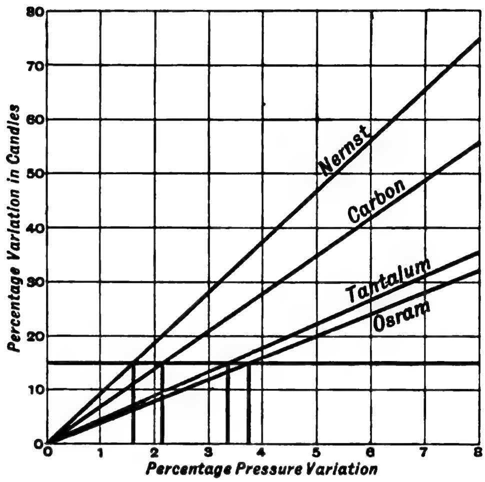
It is also gratifying to observe that the bulbs of some types of metallic filament lamps are effect upon the electric industry which would follow the sudden introduction of, say, Tungsten lamps capable of giving only eight candle-power at one watt per candle at 250 volts.

As I have pointed out previously, the present state of things serves to enable us to tide over the inconvenient transition.

Another quality for which metallic filament lamps are remarkable is the fact that their resistance, unlike that of carbon, increases with temperature; this is indicated in Fig. 3.

Partially owing to this change in resistance we find that a given change in pressure produces a smaller corresponding change in candle-power in the case of metallic filament lamps than in the case of carbon ones. This is advantageous because it may enable the amount of copper in a consumer's leads to be reduced since the thickness of such leads is determined by the fall in pressure allowable up to lamps. (Fig. 4.) Some details of the behaviour of different types of lamps in this way is shown in Fig. 4 and Table I.

Fig. 4.



VARIATION IN CANDLE-POWER DUE TO A GIVEN VARIATION IN P.D. FOR CARBON AND METALLIC FILAMENT LAMPS. (Bohle, *Illum. Eng.*, London, Vol. 1, p. 738.)

TABLE I.

Type of Lamp.	Percentage change in candle-power due to 1 per cent. change in P.D.				
	Hirschauer.	Morris.	Sharp.	Lab. Centrale.	Bohle.
Carbon	6·3	..	6·5	6·0	7
Graphitised..	..	..	5·5	..	..
Nernst	10·0	..	..	..	9·35
Tantalum ..	4·3	4·37–4·7	4·4	3·9	4·4
Osmium	4·2	..	..	..	..
Tungsten ..	4·0	3·36–3·65	4·0	3·8	4·0

(Blondel, Congrès de Marseille, 1908.)

Percentage change in candle-power due to 1 per cent. change in P.D. in the case of carbon, graphitised, Nernst, and metallic filaments.

On the other hand there is a second effect to be considered. Metallic filament lamps have a lower specific heat than carbon ones and consequently the filaments grow hot and cold with greater rapidity. As a result their momentary physical condition fluctuates to a greater extent when the voltage applied to their terminals varies and, possibly on this account, metallic filament lamps do not give quite such good results on alternating currents as on direct currents. The Tantalum lamp, as is well known, has not as yet been much employed with success on an alternating current circuit. I have been informed by Dr. Feuerlein that this is to be attributed (among other effects) to the attractive action of adjacent filaments on one another.

This gives rise to a continual mechanical trembling, and Tantalum has a property, common to the iron group of metals, of rapidly becoming crystalline under these conditions.

Some experiments recently published by Scarpa ("Atti della Assoc. Elettrotecnica Italiana," January-February, 1909), seem to be in agreement with this suggestion.

I am informed that experiments are being carried out as a result of which it is hoped to overcome this defect. But at the present moment the makers do not recommend these lamps for alternating current circuits at the same efficiencies as for direct current.

An interesting result following from the decrease in resistance of metallic filaments with increasing temperature becomes evident at the moment the lamp is switched on. In the case of a carbon lamp the initial value of the current is much lower than its final value, and we see a lamp gradually light up if it be one of high candle-power.

On the other hand, in the case of a Tungsten lamp the starting resistance is much lower, say, only one-eighth of its final value, and the instantaneous current is, therefore, eight times as high. This is illustrated by the tracings of some oscillograph curves recently obtained by Freeman (*Elec. World*, N.Y., Aug 15th, 1908) and Professor J. T. Morris (*Electrician*, June 7th, 1907), showing the rapid variation of current in a carbon or metallic filament lamp before it obtains its final value. The difference in behaviour of a carbon and Tungsten lamp is, therefore, marked, and it has been suggested that the occasional habit of metallic filament lamps of burning out the moment they are switched on is due to this effect.

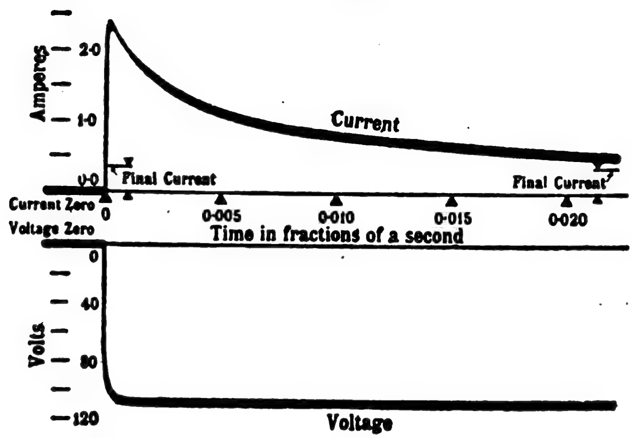
One interesting type of lamp recently brought out in Germany contains a small carbon fila-

ment in series with the main Tungsten filament (see B. Duschnitz, *Illuminating Engineer*, Vol. I., page 817). This is shown in Fig. 6.

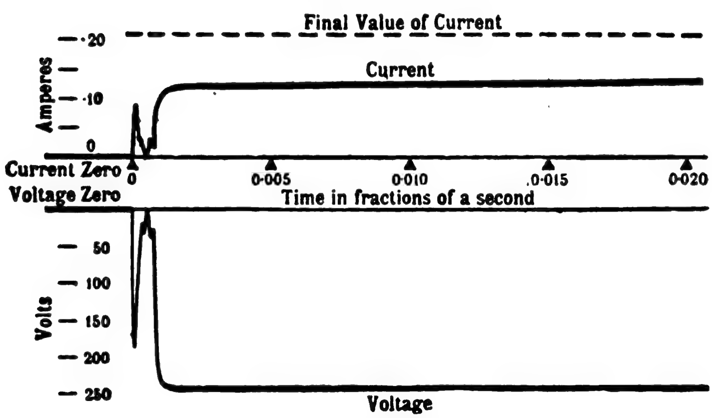
By this means the inconveniences resulting from being obliged to make a filament perhaps a thousand millimetres long and 0·03 millimetres in diameter, as is necessary in the case of a 220 volt 32 candle-power lamp, are partially avoided, for the small carbon filament supplies the required resistance and enables us to secure a lamp which consumes about 1·5 watts per candle, and yet absorbs less actual current than the 16 candle-power carbon filament lamp.

An incidental advantage in these lamps is that the high cold resistance of the carbon filament prevents the initial rush of current characteristic of metallic filament lamps to some extent, the instantaneous current, during switching on, being only twice its final value.

Fig. 5.



—Oscillogram of Starting Current in a 110 v. 32 c.p. Osram Lamp.



—Oscillogram of Starting Current in 220 v. 5 c.p. Carbon Filament Lamp.

Illustrating Growth of Current through Carbon and Tungsten Filament Lamps when Switched on. (Prof. J. T. Morris, *Electrician*, June 7th, 1907.)

This lamp I have here on exhibition. (Fig. 6, p. 766.)

Transformers.—The mention of this lamp brings to mind another development in metallic filament lighting which has caused considerable interest, namely, the use of Tungsten lamps with a transformer. If an alternating current P.D. of, say, 200 volts be transformed down to

25 we are enabled to get all the advantages of the short and stout low voltage Tungsten lamp, the metallic filament being peculiarly well adapted for low voltages, and we have also the incidental advantage of much greater safety.

On the other hand, this system certainly can not be applied indiscriminately, partly because of the high initial cost of the transformer and expense entailed in the substitution of lamps of the lower P.D., and partly because it is very wasteful to have a transformer in action continuously if only a few lamps are switched on. These drawbacks have been to some extent got over by the introduction of automatic switches which cut the transformer out when no lamps are on the circuit. M. Weissman has also

FIG. 6.

THE "ECONO" LAMP.

recently developed the method of applying a small transformer to a special group of lamps, so that it is switched on only when the lamps are switched on, and is, therefore, always working at its highest efficiency.

This system has much to recommend it, and has been found particularly acceptable in the case of lighting illuminated signs outlined in glow lamps, for in this case it is often immaterial whether we have a 2 candle-power or a 16 candle-power lamp on, and lamps and transformer can be switched on together.

Recently the Rheinisch-Westfalische Elektro-Sparlicht Gesellschaft (Essen, Germany) have put on the market a small transformer and lamp in one unit. By this arrangement each individual point is worked at the highest efficiency. The transformers are constructed to take only one size of lamp, and this non-interchangeability makes it impossible to place a bigger or smaller lamp in the same socket. The introduction of this combined unit has much in its favour in those localities in which electricity is supplied, at a fixed charge per point installed in the building. The above system enables central stations to keep a control over a consumer who might otherwise try to change the size of the lamp for which he is charged for one of a higher candle-power. However, it remains to be seen how far progress in the direction of making high voltage low candle-power lamps will render the use of transformers superfluous.

Other Drawbacks of Metallic Filament Lamps. — There are still a number of defects of more or less consequence affecting the Tungsten lamps. For instance, it must be realised that the fragile nature of their filaments, and the large number of breakages that sometimes occur in transport in consequence are very inconvenient.

In addition, one occasionally finds an exceptional and badly manufactured lamp that blackens very prematurely. It is consoling to learn from a recent utterance of Mr. Hirst (Institute of Electrical Engineers, 1908) that manufacturers are prepared to replace lamps that admittedly fail in this way.

And lastly, I may refer to one difficulty, arising from the great length of the filament in the case of metallic lamps, with which most of you are doubtless familiar, namely, the difficulty of making such lamps burn in any but a vertical hanging position. At one time it was found that any lamp burned in a horizontal or even an inclined position suffered because the filaments softened with increasing temperature, tended to sag, and ultimately came in contact and raised a short circuit. An allied difficulty was due to the fact that the expansion of such a length of filament tended to wrench it away from its support.

Both these effects have been to a large extent remedied by the "Z" and other companies by providing a spring loop capable of taking up this additional sag, and retaining the filament in its correct rigid position. To day lamps for 200 volts capable of burning in any position can be obtained. I will now throw upon the screen the actual filaments of several types of lamps, and you will see how the sag, occurring when the current is switched on, is taken up in the various cases.

I have dwelt upon the subject of glow lamps as far as time permits me to do on the present occasion; for further details I can only invite you to inspect the actual specimens on exhibition, and to make enquiries of the

representatives of the various makes who are present to-night.

Conditions of Lamp Industry in the United States as compared with those in this country.

Before leaving the subject, however, I would like to comment on one respect in which the practice in the United States differs very greatly from that in this country. Over here we have, as you know, many quite distinct makers, but mostly importers and dealers of lamps all competing against one another, and all claiming very special and peculiar merits for the particular types of lamps they represent. At the same time we have central stations all over the country employing a marvellous variety of pressures and other conditions of supply, and feeling very dubious as to the exact influence of the introduction of the new lamps on their revenue. The natural result has been that the central stations and the metallic lamp manufacturers do not co-operate to any extent and do not work in harmony. A particular illustration of this is furnished by the difference in the pressure at the consumer's terminals even in large districts in London. It is not only that the declared pressure varies, but it is also a fact that the latitude which the central stations allow in this nominal voltage also fluctuates very greatly.

Permissible Variation in P.D. at Consumer's Terminals.

The voltage, for instance, may be nominally 200, and yet actual records may show that it is near 210 or even 220 during a section of the night, and this notwithstanding the fact that it is clearly laid down by law that the pressure at the consumer's terminals should not fluctuate by more than plus or minus 4 per cent.

It need hardly be pointed out how unfair this is to the lamp maker, who, if he supplies lamps correctly graduated to suit nominal voltage, soon finds that the life of the lamps supplied gives rise to much complaint.

At a recent meeting of the Institution of Electrical Engineers (discussion of Paper by Mr. C. Paterson, 1907) one of the speakers commented on this difficulty, and let us into a secret of one method of trying to meet it—which will receive our sympathy, if certainly not our entire commendation—of supplying lamps marked for the nominal voltage, but really suited to the average actual value likely to occur in that district.

Instances of Co-operation in the United States.

In this connection I would like to draw your attention to the work of the National Electric Light Association in the United States. All the chief lamp makers in that country, who are, however, comparatively few in number, belong to this Association, which supports a laboratory for the purpose of carrying out common tests on glow lamps for the common benefit. In addition, the lamp makers are in constant co-operation with the central station who, indeed, very generally actually supply lamps to their customers, and who, therefore, are in a position to advise them also as to the best means of employing such lamps in their houses.

The recognition by the National Electric Lamp Association of the value of scientific study is exemplified by the fact that the Association has now installed and proposes to maintain at considerable cost, a special laboratory for the study of illumination from the joint standpoint of the ophthalmist and physicist. It is anticipated that much good work will be undertaken at this laboratory for the benefit of the general public and the lighting industry. This splendid example I would like to see imitated in this country.

Another striking example of co-operation between central station lamp manufacturer and consumer is afforded by the action of the Boston Edison Electric Illuminating Co., to whom belongs the honour of being the first supply company to organise an expert staff of illuminating engineers, from whose advice company and consumer alike could benefit.

During the three months that have elapsed since the inauguration of this department under the supervision of Dr. Louis Bell, the President of the Illuminating Engineering Society in the United States, no fewer than 450 applications for assistance have been received from customers, and advice was given free. It is also interesting to know that this number included no less than 19 churches.

We commend to the electric lighting industry of this country the far-seeing policy of our neighbours in the United States.

Another aspect of this question which is causing some anxiety to those in a position to know is the approach of a wholesale reduction in prices of lamps, coupled with the accompanying danger that a large number of cheap but inferior lamps may be put upon the market in this country (possibly the discarded examples of lamps used abroad), just as

happened when the carbon filament lamp was first developed.

The Need for a Standard Specification.

We have now a standard specification by which the consumer may profit if he chooses to do so, while buying carbon filament lamps. Some experiments in this direction have been made in Germany, having for their object the framing of a similar standard specification to be applied to metallic filament lamps, and I understand that attention is being devoted to the matter by the National Physical Laboratory in this country. In any case the time is coming when the desirability of such a standard will be very keenly felt. The great difficulty, however, in drafting a specification and in giving it practical effect lies in the fluctuation in the conditions to which the lamps may be subjected.

As explained above, we may mark on a lamp the conditions with which it ought to comply when properly treated; but, when it is placed on a circuit on which the voltage is only nominally and not actually that marked on the lamp, we shall, naturally, not obtain the results that compliance with the specification is supposed to secure.

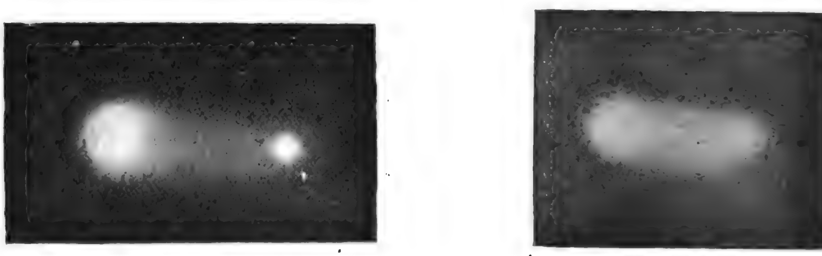
Arc Lamps.

In turning to the subject of arc lamps, I am again impressed by the extent of the material at my disposal, and the short time in which to make reference to the subject. Naturally, my remarks can only be very general, and I cannot enter into details of mechanism but only into general principles.

Two of the main factors of the old open carbon arc lamp on which attention has been concentrated, have been the luminous efficiency of the carbons and their life. We can, of course, always increase the efficiency of a carbon arc by reducing the diameter of the carbons, and so securing a higher temperature of incandescence. But by so doing we also increase their rate of burning away correspondingly.

In the ordinary carbon arc, as you are doubtless aware, the great majority of the light is thrown from a white hot incandescent spot of a positive carbon which we call the crater; the light from the arc itself, and even from the negative carbon, is relatively small. We have, therefore, to deal essentially with thermal radiation of an incandescent solid, and under these conditions the luminous efficiency is bound to be small because we produce a mere jumble of vibrations in which heat waves which are useless from the luminous point of view, predominate.

Fig. 7.



Ordinary Arc. Flame Arc.

Illustrating the appearance of Arcs between Ordinary and Flame Carbons respectively.
(Andrews, Inst. of Elec. Engineers, 1906.)

Incandescent Vapours.—Recourse has therefore, been had to a second possible wa of increasing efficiency, namely, by the use c the principle of luminescence and the fre natural vibrations of a vapour instead of solid. This was accomplished by introducin a suitable volatile chemical substance into th carbons.

Flame Carbons.—Many attempts were mad in this direction, both in the direction of im pregnating the carbons with a solution, and i providing them with a suitable chemical core

Under these conditions it was found to b possible to obtain a bridge of highly luminou vapour, from which the greater portion of a ligl is received. There were, however, many diffi culties in the application of this principle. F instance, the early carbons were not sufficientl homogeneous and burnt with a flickering ligh In addition the chemical materials tended t

form a fusible non-conducting slag on the top of the carbons which interrupted the action of the arc.

This last difficulty was largely overcome by the introduction of inclined carbons.

Fig. 7, which represents some date given by Mr. Leonard Andrews in a paper before the Institution of Electrical Engineers three years ago, makes clear the difference in the nature of the arc between pure carbon electrodes and the flame arc. In the latter case the vapour is a source of light, and in addition it is necessary to use a much longer arc of perhaps as large as three-quarters to one inch in length. Under these conditions we avoid the shadow from the negative carbon, characteristic of ordinary arc lamps, and thus save a considerable amount of light that would otherwise be wasted.

On the other hand, it has been pointed out that the distribution of light so secured is unfavourable for street lighting and, therefore, M. Blondel has recently brought out a patent type of carbons which enables a highly efficient white arc to be obtained between vertical electrodes. Carbons of this type are utilised in the Crompton-Blondel arc. (Fig. 8.)

The efficiency of a flame arc is far greater than that attained by the old type, reaching, under favourable conditions, as much as 0·2 watts per candle-power (M.S.C.P. naked arc). Some recent figures of Professor Morris on this subject are presented in the following table:—

Efficiency of Various Types of Carbons and Arc Lamps.

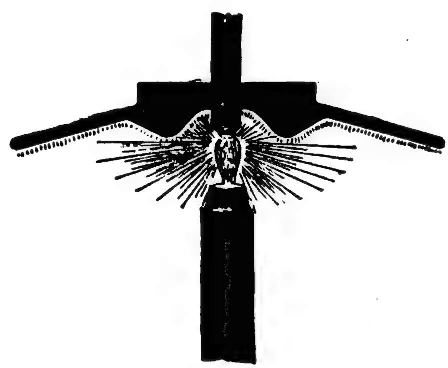
(Morris, *Illuminating Engineer*, Sept., 1908).

	M.S.C.P. per Watt.
Carbons.	
High Grade Flame Carbons ..	2·9 to 3·3
Lower Grade ,, ,, ..	1·5 to 2·5
Ordinary Carbons Open	About 1
,, ,, Enclosed ..	About 0·6
Lamps.	
Lamp with High Grade Flame Carbons Enclosed	3·9
Ditto Open	3·5 to 3·7
Lamp with Auer Carbons	2·5
Lamp with Lower Grade Flame Carbons	1·4 to 2·5
Lamp with ordinary Carbons Open	About 1
,, ,, ,, Enclosed	About 0·75

Since the first commercial introduction of a successful flame by Bremer, many different types of flame lamps have been evolved. I can only make passing reference to a few of these, such as the Excello, Crompton-Blondel, Gilbert, Oliver, &c. The essential characteristic of all flame lamps is that the light is mainly, though not entirely, derived from luminescent vapour.

Efforts to Increase Burning-hours of Flame Carbons.—Even in the case of flame arcs, however, the gain in the efficiency was only secured with an accompanying increase in the rapidity of the wasting away of the carbons. Enormous candle-powers were obtained, but the first lamps produced only burnt for about six hours without re-carboning, and even so extremely long carbons had to be used, thus making the overall length of the lamp inconveniently large.

Fig. 8.



The Crompton-Blondel Arc.

Oliver Magazine Lamp.—The design of flame carbons has got over this difficulty to some extent, but only partially. An ingenious method of meeting the difficulty was that adopted in magazine flame lamps, of which the Oliver lamp was an example. In this case a succession of carbons is stored within the lamp, and the wasted carbon being automatically replaced is thus used up. Evidently a lamp on this principle can burn for a considerable time without re-carboning. On the other hand, mechanism of this type is inclined to get out of order.

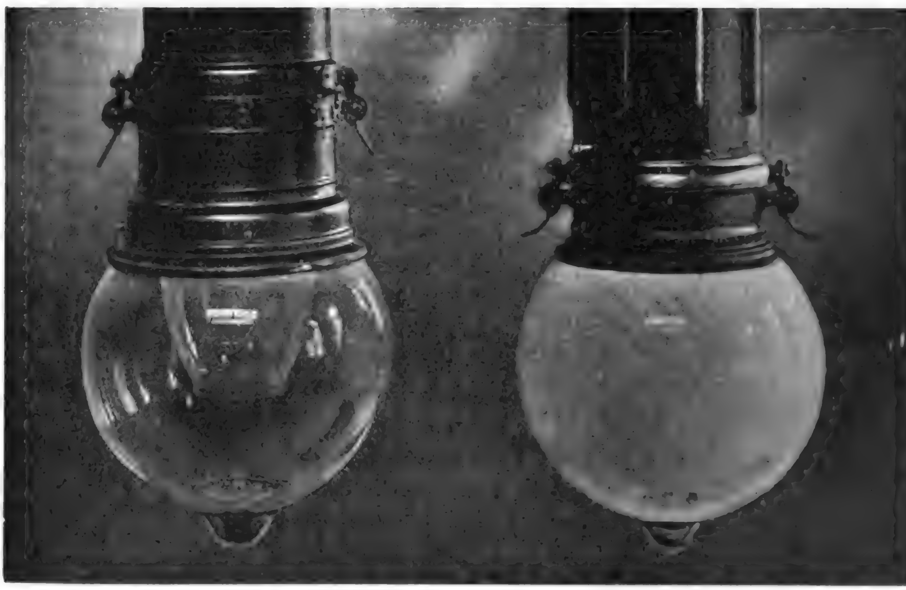
Enclosed Flame Arc Lamp.—It might naturally have been supposed that an attempt would be made to enclose flame lamps as had been done successfully in the case of the arc between pure carbons. In the United States in particular, where labour is dear, lamps of this type had had a great success. Unfortunately the deposition of fumes on the globe of the lamp and the quickly increasing opacity as a consequence, and also the fact that the efficiency of most flame carbons was

considerably diminished when air was excluded, prevented this plan being feasible. Indeed, the condensation of fumes inside the globe has been found to be a defect in most flame arc lamps of the ordinary variety.

More recently, however, a modification has been made by the Union Electric Company in the Excello lamp, involving the introduction of an inner globe, which causes the fumes to be carried away and condensed elsewhere; the same firm utilise a type of inner globe which, being prismatic, serves the purpose of modifying the natural curve of light moved and very long burning hours are secured. A general view of this lamp is shown in Fig. 10, p. 771.)

Lamps with Metallic Electrodes.—Another distinct direction in which the researches of arc lamps have progressed during recent years has been towards the complete replacing of carbons by metallic electrodes. Ladoff, Blondel, and others have done much work in this direction. The best known commercial type of lamp dependent on this principle, however, is the magnetite arc brought out by the General Electric Company in the United States.

Fig. 9.



Excello Deposit-Free Globe.
Appearance of ordinary and deposit-free cover after 100 hours burning.

distribution, so as to render it convenient for street lighting.

Two pairs of carbons burning consecutively are also used, and this is said to enable the lamps to burn for 34 hours without re-carboning; in a very still atmosphere as much as 42 hours has even been obtained. It is also stated that the efficiency of this lamp is of the order of 0·17 watts per M.H.C.P. In Fig. 9 will be seen the appearance of the globes of two identical lamps, one fitted with ordinary globe and the other with the new deposit free type, after 100 hours burning.

Very recently, too, Mr. Denman Jones has brought out a type of enclosed flame arc, by the aid of which the gases are completely re-

This lamp utilises a negative electrode composed of a suitable mixture of magnetite and oxides of the rare metal titanium and other substances. A very long luminous arc is obtained, the quality of which, however, depends entirely on the constitution of the negative electrode. The positive electrode merely consists of a slab of copper. It has no influence on the quality of the light, nor does it waste away. The negative, however, wastes away at such a slow rate that the lamp, it is said, can be burnt 500 hours without re-carboning.

It is also said that the quality of the light, unlike that from most flame carbons, is extremely white; also that it is good for geographical purposes. (It is interesting to observe that the

lamp has just been adopted for the street-lighting of Boston, as the result of exhaustive tests by the authorities in that city.) This, therefore, represents a departure in the direction of securing efficiency coupled with long life.

Miniature Arc Lamps. — Before leaving the subject of arc lamps, reference may, perhaps, be made to one other interesting development in arc lighting, namely, the introduction of miniature enclosed arc lamps taking a small current of perhaps 1-2 ampères only. It was long felt that there was a need of some source having a candle-power intermediate between that of the carbon filament and the arc lamp.

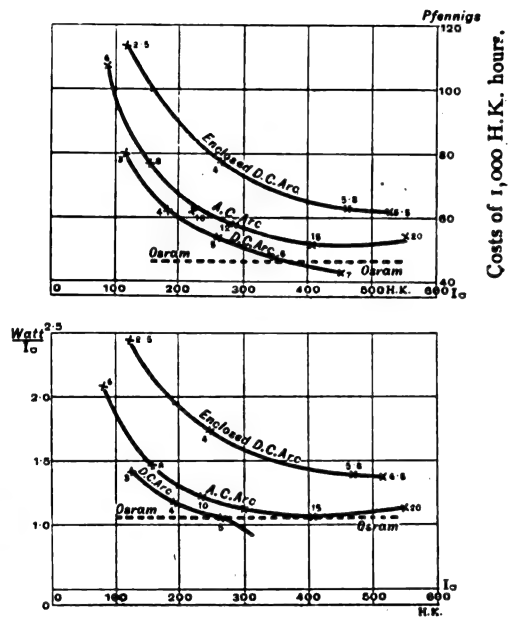
FIG. 10.

THE JANDUS REGENERATIVE ENCLOSED FLAME ARC LAMP.

The introduction of flame carbons only resulted in the production of lights of more enormous candle-power than ever, while it was found difficult to make carbon filament glow lamps of high candle-power. The Nernst lamp, it is true, did something to fill the gap, but its complexity was a disadvantage. Shortly afterwards there arose a rapid succession of small enclosed arc lamps of this kind called by various names, the Miniature, Mignon, Rignon, Baby, Lilliput, &c.

The Regina Arc Lamp.—The Regina Arc Lamp Company claim to have achieved an improvement in their Regina, Helia, and Reginula enclosed lamps by securing a more complete exclusion of the air than had been previously found possible, coupled with a reduction in the diameter of the carbons used. It is claimed, for instance, that the Regina lamp consumes only 0·8 watts per M.H.S.C.P., and will last for 250 hours without re-carboning.

FIG. 11.



COMPARISON OF ENCLOSED ARC LAMPS AND HIGH CANDLE-POWER OSRAM LAMPS. (H. Remané, Verband Deutscher Elektrotechniker, 1908.)

The numbers attached to the points on the curve represent the current in Ampères taken by the various Arc Lamps.

A consumption of only 0·3 watts per M.H.S.C.P. therefore can be obtained if one is content with a burning period of only 15 to 20 hours. An example of the extremely simple character of the mechanism of these lamps is kindly exhibited by Messrs. Marples, Leach and Co., to-night.

Comparison of Small Arc Lamps and High Candle-power Tungsten Lamps.—More recently still, however, a change in the situation has been brought about by the introduction of high candle-power Tungsten lamps, which rival the most efficient enclosed arc in efficiency and are without the disadvantage of

requiring occasional attention. The relative merits of both types of lamps has been recently treated by H. Remanè (E. T. Z., Aug. 20th, 1908), some of whose results are exhibited in Fig. 11.

HOME INDUSTRIES.

The Coal Industry.—The coal strike that threatened to affect the whole of the United Kingdom has been averted. The minimum wage asked for by the Scottish miners has been conceded, whilst the variation and limit of wages above that minimum are to be arbitrated upon. The agreement is for three years. At one time last week the country was very near what would have been nothing short of a great national calamity, for with the coal pits idle every leading industry in the country would be affected. The dispute now so happily settled will give strength to the suggestion of a Wages Board for the whole of Great Britain, having for its object the ending of those great fluctuations which occur in the coal trade where the price is up to 15s. or 16s. a ton one year, and down to 6s. or 7s. a ton another year. It would be of enormous advantage to the trade of the country if manufacturers and others were able to enter into their contracts knowing that the price of coal will not be materially interfered with. Whilst there is general satisfaction at the settlement of the dispute the crisis has lent colour to the contention of those who say that agreements between masters and men for the purpose of regulating wages work well enough whilst trade is good, but fail when the men are asked to accept lower wages. The Scotch coalowners only asked of the men what the agreement under which masters and men worked entitled them to ask, just as they previously conceded the increase of wages to which the men were entitled under the agreement. And as has been said more than once in these Notes the Eight Hours Act, which was intended to benefit the men, has, in fact, gone near to doing them serious injury, because those who supported it in Parliament, at any rate its responsible authors, did not realise the difficulties of putting it into operation without endangering the relations of employers with employed. It was only business men intimately acquainted with the trade who foresaw the complications that have followed its being put into force. In these days one does not often see quotations from Sir Archibald Alison, but a passage in his autobiography may be quoted in this connection. Having discussed the arrestment of wages in Scotland, to which throughout his strenuous life Sir Archibald was stoutly opposed, he goes on to say, "This leads me to remark how great an evil all persons practically engaged in the administration of affairs find it to be, that laws are in general passed in the legislature by persons almost entirely unacquainted with their practical operation when put in force . . . The speculative part of the assembly, whose feelings prompt them to support measures calculated for the general good, are very often destitute of the practical knowledge necessary to carry their views into effect, and vehemently support measures seemingly beneficial, but which in reality have often in the end a pernicious effect. The most obvious way of rectifying this great evil, which materially neutralises the good effect of free institutions, is to compose the Cabinet for the most part of persons trained in the administration of affairs, like the intendants of provinces in the old French monarchy—a system which produced a Sully, a Colbert, a Torcy, and a Luvois. But how such a system is to be reconciled with the necessities of government in a constitutional monarchy, depending on the majority of a popularly elected assembly, to be swayed mainly by the oratorical talents of its members, constitutes a difficulty which probably will never be wholly overcome."

Textile Workers and Half-Time.—The chief subject dealt with in the annual report of the United Textile Factory Workers' Association was the employment of children in cotton mills, and it is not surprising that regret should be expressed at the result of the ballot on the half-timer's question which gave a large majority in favour of maintaining the present system. It cannot come as a surprise to those who have studied the question that the system has a deep and strong hold on textile workers. The report says that the reason of the opposition to raising the age at which young people may begin to work in cotton mills is difficult to explain, but is it? "It is a sad fact," writes Mr. Allan Clarke in his book, "The Effects of the Factory System," "that the majority of parents in Lancashire regard children only as commercial speculations, to be turned into wage-earning machines as soon as the child's age and the law will permit. For this they oppose the raising of the age of half-timers; for this resent all legislative interference, either educational or hygienic, in the matter of their children." Two years ago the Half-time Council found that there was a progressive gain of height and weight in the all-day school children of both sexes over the half-timers of similar ages. Similar observations were made lately upon 1,000 children in each of these classes, with the following average results:—

	All-day School Children. Height. ft. ins.	All-day School Children. Weight. st. lbs.	Half-timers. Height. ft. ins.	Half-timers. Weight. st. lbs.
12½ years	4 7½	5 4½	4 7	5 3
13¾ "	4 7½	5 6	4 7	5 4
13–14 "	4 9½	5 11½	4 8½	5 8¾

This shows the half-timer at 14 to be much less in height and 2¾ lbs. less in weight than the all-day school child of the same age. Nor is it only that the half-time deteriorates physically. The effect of factory life upon the morals of both boys and girls is deplorable, whilst educationally the half-time system

stands self-condemned. The Conference adopted a resolution which appeals to all parents to make some sacrifice in the interests of the physical and educational attainments of the children, and to support the movement for increasing the age of work to thirteen years.

Cotton Ginning and Baling.—Two bales of American cotton that have been on view in the Manchester Royal Exchange show a considerable improvement on the old. These bales were ginned and compressed by the Modern Gin and Compress Company. It is claimed for this style of ginning that it raises all low cotton at least one grade. In the old system of ginning a brush is used for taking the lint off the saws, under the new system an air blast is used, and in the place where the brush usually is (directly behind the saws) there is a cylindrical chamber into which the dust and rubbish found in low cotton are driven by centrifugal force. In brush gins some of this dirt is carried into the cotton by the brush, and so on into the bale.

Artificial Nitrates. — An American has just patented in this country an invention for the manufacture of artificial nitrates. It is claimed that nitrate of lime can be produced at a cost of about £4 14s. a ton, the market price of Chili saltpetre being about £9 15s. a ton. Until now the principal attempts that have been made to fix atmospheric nitrogen may be classed as (1) processes in which atmospheric nitrogen is burnt to nitrous or nitric acid; and (2) processes in which atmospheric nitrogen is combined by means of carbides, obtained by fusing together in an electric furnace metals or metallic oxides and carbon. The cost of the nitrogen so obtained has been comparatively high, except where power can be obtained from waterfalls at a very low cost. The patent referred to above describes a process and apparatus by means of which sulphur may be burned on a commercial scale so as to remove all the oxygen from the stream of air supplied for its combustion. By this means, it is claimed, nitrogen of great purity can be obtained, and the inventor says that in practice he has rejected all nitrogen-gas which did not reach a purity of 99·6 to 99·8 per cent. Also by placing iron filings in the receiver for a few days the ·2 of oxygen may be removed, leaving absolutely pure nitrogen. Cyanide of potassium can, it is claimed, also be produced at a cost of about 8½ cents a pound, the market price being about 22 cents per lb.

The Hop Industry.—The disastrous result of last year's operations led to a large reduction of the area in hop cultivation this year, and the very unfavourable weather of the present summer makes it very unlikely that there will be anything like an average yield in 1909. Some gardens have been abandoned already on account of the aphis blight, and many are in a precarious condition because the damp weather prevents the killing of the aphis. Systematic washing prevents the ravages of blight, but constant washing is a costly business, and many growers, disheartened by the experience of last year, have decided to let the crop take its chance. Even where the aphis has been held in check the yield will be small, but having regard to the restricted area under hop cultivation this year in America, as well as this country, prices are likely to be good. It is to be feared, however, that there will be nothing in the circumstances of the present year to arrest the decline in hop cultivation which has been going on for the last twenty years, and which, in another twenty, is likely to leave the country without any hop fields, even in Kent.

QUESTIONS AND ANSWERS.

Readers in search of information which cannot be obtained from the usual sources are invited to make their wants known in the *Journal*, in the hope that they may be assisted in their difficulties by their fellow members.

On all communications must be written the name and address of the sender, not necessarily for publication, but as a guarantee of good faith.

Each question or reply should be written on a separate sheet of paper, and should bear such signature of the writer, and such address as he wishes to appear.

Questions which can be answered from the usual books of reference, will not be printed.

ANSWERS.

COPRA.—There is, according to the results of some experiments of mine some time ago, no great difficulty in preventing the formation of the "mould" (*Penicillium*) referred to by "Malay," in the *Journal* of 30th ult. In cases where the odour (which, though fragrant, is somewhat persistent) is not an objection, impregnation of the copra, and especially of the sacks, casks, or cases containing it, with oil of thyme *(Ol. Thymus vulgaris)* is the most effectual method. The oil should be applied in a fine spray, about half a fluid ounce per cwt. of copra being sufficient for this purpose. As an *odourless* application, a warm saturated solution of boric acid answers well. The copra should be well washed, soaked, or sprayed with this, and sun-dried, before it is packed. A little finely-powdered boric acid should also be dusted over the top layers of the copra.—W. LASCELLES-SCOTT.

Chemical and Physical Laboratories,
Little Ilford, Essex.

BLEACHING STRAW FOR HATS.—Assuming that "Chittagong" desires to treat the fibre of the Tamil or "Talipot" palm-leaf (*Borassus flabelliformis*), or "plaits" derived therefrom—for there are several others to which the term "Palmyra Palm," is improperly applied—I think I can furnish him with the desired information. But the details vary in certain

respects with the condition of the material, hence it might be as well if he would favour me with a few specimens of the actual plaits to be treated. I may remark that, some years back, I had occasion to conduct some researches upon this very question for the late Dr. J. Forbes Watson, Director of the India Museum, to which I was then Consulting Analyst. Speaking in general terms, it may be said that no form of "sulphur-bleaching" proves so satisfactory with any "Palmyra" plaits, as with the common "straws." There are two classes of process giving good results with "Palmyra," which may be respectively designated as the "ozonic" and the "nascent oxygen" methods, the latter being an essentially chemical one. I am acquainted with the "secret" details of both, and shall be happy to send a further reply on receipt of "Chittagong's" specimens.—W. Lascelles-Scott.

Chemical and Physical Laboratories,
Little Ilford, Essex.

NOTES ON BOOKS.

Notes from a Painter's Life. By C. E. Hallé. London: Murray, 1909. 6s. net.

The chief interest in Mr. Hallé's sketch is certainly in the account he gives of the founding and carrying on of the Grosvenor Gallery and the New Gallery. This is a record of permanent value. Besides, there are many pleasant notes on people he has known and things he has seen. By his own account his relations with his numerous friends and acquaintances were always pleasant. At all events, the unpleasant side is left unrecorded, "*Horas non numerat nisi serenas*."

A History of Art. By Dr. G. Carotti. Vol. II. (Part I.) Early Christian and Neo-Oriental Art. European Art North of the Alps. Translated by Beryl de Zoete. London: Duckworth and Co. 5s. net.

The first volume of this work, which dealt with ancient art from the Memphite age to the later Roman age, was noticed in these columns in December last. In the present volume some sixty pages are devoted to early Christian art, and the remaining two hundred and sixty to neo-Oriental and European art. From the scope of the book it will be seen that Dr. Carotti makes no claim to describe with any minuteness his subject—indeed, he freely admits that his work is elementary and introductory in its intention; but, as the translator observes, "the value of such a panorama depends perhaps less on its fulness than on the stimulus it affords the adventurous imagination to more extensive researches." Dr. Carotti is eminently qualified to sketch in large outline the history of art; while for those who desire to pursue the subject, or any portion of it, in greater detail—and to stimulate such a study is, no doubt, the author's principal object—the bibliography at the close of the volume should prove invaluable. Three hundred and sixty illustrations add much to the usefulness of the book: the only pity is that they could not have been reproduced on a somewhat larger scale.

GENERAL NOTES.

The Architectural and Topographical Society. — The Architectural and Topographical Society, which was founded about a year ago, is appealing for a minimum sum of £500, "to ensure the effective continuation of its work until such time as the annual subscription list shall be equal to the necessary disbursements." The society's object is to make complete historical records of the ancient buildings of these islands from the introduction of civilisation to the year 1800, and already in the short period that has elapsed since its establishment, the society has published complete accounts of the buildings in seventeen parishes. The recent appointment of Royal Commissions to make an inventory of the ancient monuments of England, Scotland, and Wales shows that the State appreciates the need for such work, while further testimony to its value is furnished by the fact that many of the leading institutions interested in the subject are subscribing to the Architectural and Topographical Society. The appeal is signed by the Earl of Plymouth, Lord Avebury, Sir Aston Webb, Mr. Thomas G. Jackson, and other well-known authorities, and it is to be hoped that the society will be successful in raising the modest sum necessary to carry on a work of such great national interest and importance. Subscriptions should be sent to the Secretary, 33, Old Queen-street, Westminster, S.W.

British Machinery in Japan.—It is satisfactory to find that the British share of machinery sent to Japan in 1908 increased from 52 per cent. in 1907, to 59 per cent. This large proportion was mainly due to increased purchases of cotton-spinning machinery, but except in the cases of electric and paper-making machinery, and to a lesser extent as regards pumping and sawing machinery, the United Kingdom holds a long lead over her two nearest competitors, the United States and Germany. In electric machinery Great Britain has dropped behind, and in his report on the trade of Japan, just issued, Mr. E. F. Crowe, Commercial Attaché to his Britannic Majesty's Embassy at Tokio, says that the outlook is not very promising, as one of the largest American concerns is about to combine with an already established Japanese engineering works, and start manufacturing locally on a big scale. The number of spinning companies in Japan, at the end of 1908, was thirty-five, with 1,358,000 working spindles, of which 1,310,000 were ring and the balance mule. Several of the leading spinning companies have now taken to manufacturing.

Journal of the Royal Society of Arts.

No. 2,960. VOL. LVII.

FRIDAY, AUGUST 13, 1909.

All communications for the Society should be addressed to the Secretary, John street, Adelphi, W.C.

NOTICES.

"OWEN JONES" PRIZES FOR INDUSTRIAL DESIGN.

The Council of the Royal Society of Arts hold a sum of £400, the balance of the subscriptions to the Owen Jones Memorial Fund, presented to them by the committee of that fund in 1876, on condition that the interest thereof be spent in prizes to "Students of Schools of Art who, in annual competition, produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damasks, Chintzes, &c., regulated by the principles laid down by Owen Jones."

Competitions, under the terms of this Trust, have been held annually since 1878.

The next award will be made in 1910, when six prizes are offered for competition, each prize to consist of a bound copy of "The Leading Principles in Composition of Ornament of Every Period," from the "Grammar of Ornament," by Owen Jones, and the Society's bronze medal.

The prizes will be awarded on the report of the examiners in the national competition of the Board of Education. The designs must be submitted in the usual manner to the Board of Education, South Kensington, S.W., by the 1st of April, 1910. They must be marked "In competition for the Owen Jones Prizes," and must comply with the regulations of the Board of Education.

No candidate who has gained one of the above prizes can again take part in the competition.

Notice of the offer of these prizes has been sent to the Schools of Art connected with the Board of Education; and copies of the circular can be obtained on application to the Secretary of the Royal Society of Arts, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

MODERN METHODS OF ARTIFICIAL ILLUMINATION.

By Leon Gaster, A.M.I.E.E.

(Editor of the *Illuminating Engineer.*)

PART II.*

VAPOUR LAMPS.

Introduction.—It will be remembered that at the beginning of Part I. I referred to the existence of two distinct methods of generating light—by incandescent solids and by luminous gases; I have also mentioned how we may expect to secure more efficient results by the utilisation of radiation of the latter variety.

A flame lamp, as we have seen, utilises both types of radiation, and accordingly exhibits one disadvantage of luminescence, namely, the fact that we usually succeed in producing one portion of the spectrum with greater intensity than another, and therefore get light of a colour which differs considerably from daylight, and might even be practically bizarre.

The Mercury Arc Lamp.—I have now, however, to speak of another type of lamp, which seems to utilise luminescence alone, namely, that employing metallic vapours. It may be said at once that the only metal which has been successfully employed in this way, is mercury.

As in the case of incandescent lamps it may again be mentioned that not a little of the early pioneer work in this department was done in England, some of the earliest efforts being ascribed to Rapieff in Russia, and to Way and, more recently, to Bastian in Great Britain. The lamp was brought to a more practical stage by the subsequent experi-

* The Course consisted of four lectures, delivered on February 15th and 22nd, and March 1st and 8th. In re-arranging the material for publication in the *Journal*, the lecturer has preferred to divide it into six parts.

ments of Arons in Germany, and Cooper-Hewitt in the United States. Both of these investigators utilised a long tube containing mercury vapour, which is essentially the same as that used in the mercury vapour lamps of to-day.

There have, however, been a number of very ingenious inventions regarding the regulating mechanism of these lamps, into which I cannot enter in detail. A few of the most recent types of lamps of this kind are shown here by the kindness of the Westinghouse Company to-night.

The chief point of interest in the most recent type introduced by this firm is the introduction of a new automatic system of starting the lamp without "tipping," the arc being started by the impression of instantaneous high P.D. across its terminals.

The efficiency of these lamps is difficult to determine, because of the peculiar character of the light, and also because the extended nature of the source makes accurate photometry very difficult. It has, however, been stated that a consumption as low as 0·6 watts per candle-power has been obtained, and this was long thought to be the limit, since both an increase and a decrease in the pressure of the mercury vapour in the tube proved to lead to a fall in the efficiency.

The great length of tube (those of 110 volt lamps are nearly 1 metre in length and 3 to 4 centimetres in diameter), though promoting diffusion of light, is a disadvantage in some respects.

The greatest disadvantage under which these lamps labour, however, is the peculiar colour of the light. A line spectrum pure and simple is obtained, the greater bulk of the radiation being concentrated in three lines into yellow, green, and blue respectively, and the red element being almost entirely absent. This line spectrum is, of course, characteristic of luminescence.

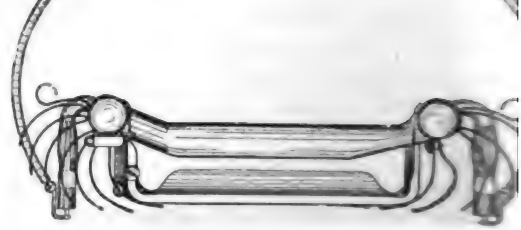
I cannot dwell upon all the attempts that have been made to improve the colour of the light. They are many. For instance, it has been proposed to mix lithium salts in the mercury in order to provide red lines in the spectrum; also to modify the spectrum by the use of special electrodes; also to derive red light by the degradation of the ultra-violet rays given by the lamp by means of fluorescence. None of these methods appears yet to have crystallised into anything very practical.

The Küch Quartz-Tube Lamp.—Recently, however, an interesting advance has been made in Germany by Dr. Küch. (Paper read before the Verband Deutscher Elektrotechniker 1907.) Hitherto, if the pressure within the lamp was increased beyond a certain point, the increase in temperature caused glass of an ordinary variety to melt, and therefore brought the lamp to a premature end.

Quartz-Tube lamps, intended mainly for the production of ultra-violet light, and not for ordinary purposes of illumination, had previously been introduced by Heraeus, in Hanover, Germany.

FIG. 12.

General Appearance of Küch Lamp.



Small Quartz Tube.

THE KÜCH LAMP. A Mercury Vapour Lamp utilising a small tube composed of special quartz glass.

Dr. Küch, however, constructed a tube of very refractory special quartz glass which would stand a much higher temperature than ordinary glass; it was then found that the efficiency increased as the power given to the lamp was increased, in accordance with the curve shown in Fig. 13.

It will be seen that the consumption per candle-power, after rising to a maximum, begins to fall again, until eventually a value of about 0·27 watts per M.S.C.P. is attained.

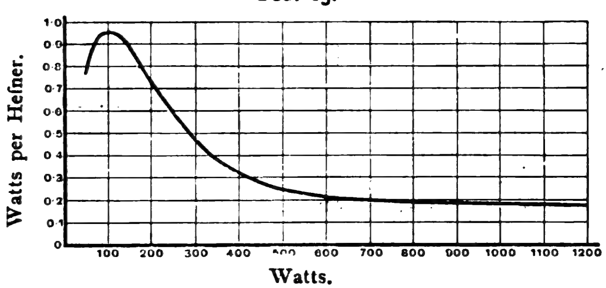
The quartz 110 volt tube is only about 8 centimetres long and 1½ centimetres in diameter. I may say that the glass of this tube represents a very considerable item in the total cost of the lamp.

many for purely photographic purposes, some of them, such as the Heraeus lamp, employing quartz glass; others, like the Uviol lamp, utilise an envelope composed of a newly-discovered glass, which transmits ultra-violet energy.

The Moore Tube. — And now I have to mention a very interesting type of an illuminant recently brought out in the United States by Mr. D. Macfarlane Moore (Am. Inst. of Elec. Engineers, 1906).

It has, of course, long been known that gases can be made luminous when subjected to an electrical discharge in a highly rarified condition. The ordinary Geissler and vacuum tubes are illustrations of this principle. To

FIG. 13.



CURVE ILLUSTRATING EFFECT ON EFFICIENCY OF KÜCH LAMP OF INCREASING WATTAGE AND TEMPERATURE.

Another interesting characteristic of the lamp is the fact that at the high temperature and pressure existing within the lamp luminescence is partially replaced by ordinary incandescence, and the line spectrum broadens out into a more or less continuous one, with the result that the colour of the light is distinctly improved, and contains a certain amount of red rays.

Another striking peculiarity of the lamp arises from the fact that quartz glass allows ultra-violet light to pass through, whereas glass of the ordinary variety is gradually decomposed by it, or degraded by it into heat-energy. As a result the quartz-tube lamp has a very powerful action on the skin and eyes, and is also believed to possess special uses for the destruction of bacteria, the sterilisation of water, &c. For ordinary purposes of illumination it is necessary to screen the quartz tube with an absorbing glass envelope, which transmits the visible radiation, but largely absorbs the ultra-violet light.

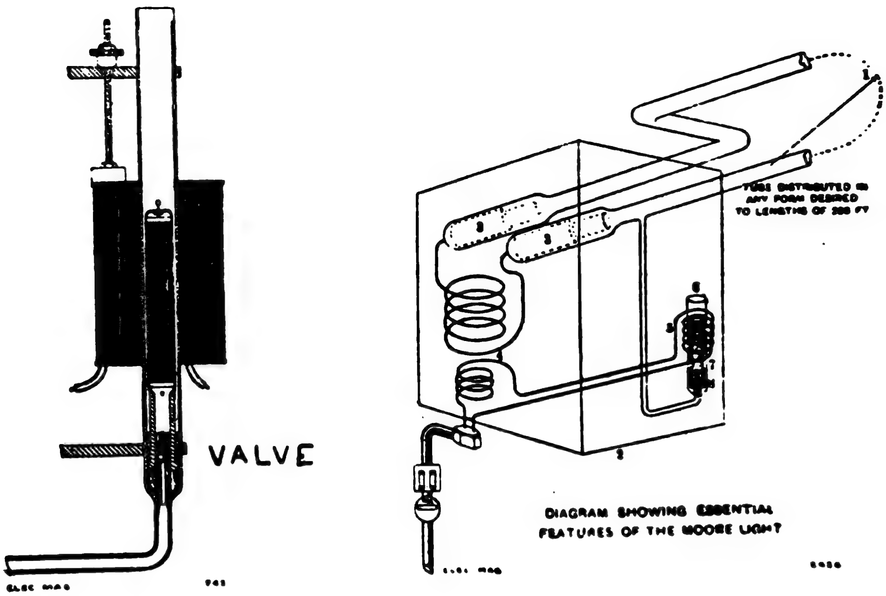
It has been mentioned that lamps of a similar character have been devised in Ger-

Tesla and others had occurred the idea of utilising this effect in order to secure an efficient illuminant. It was, however, found that the condition of the gases within the tube quickly changed, partly owing to the absorption of gas by the electrodes, and means had, therefore, to be adopted to control automatically the conditions of the gaseous contents of the tube. These devices, however, were for long unreliable.

To Mr. Moore belongs the credit of having very carefully studied the conditions and qualities of gases most favourable to the production of light, and the invention of an extremely ingenious form of valve by the aid of which the pressure of the gas within the tube was maintained exactly constant. The essential details of this valve and the lamp in general are shown in Fig. 14. During my recent visit to the United States I had the privilege of seeing these lamps in action.

The illuminant consists of a long tube, which may be 30 ft. or 40 ft. in length, filled with suitable gases at a very low pressure and subjected to an electrical high tension discharge

FIG. 14.



DETAILS OF MOORE TUBE.

FIG. 15.

MOORE TUBE INSTALLATION LATELY IN USE IN THE COURTYARD OF THE SAVOY HOTEL, LONDON.

from a small electrical transformer. If a house is lighted by this system the tube is supposed to ramify round the rooms up the staircase, &c., and, in fact, entirely to replace the ordinary wiring.

The consumption per candle-power of the tube varies according to the nature of the gas used; so does the colour of the light. Thus a tube filled with nitrogen yields light of a yellowish, pinkish colour. But by using carbon-dioxide Mr. Moore claims to obtain a beautifully white light which resembles daylight more closely than any other known illuminant.

Fig. 15 represents the Moore tube installation recently in use in the courtyard of the Savoy Hotel, and is, I believe, the only installation put up in this country. This was described by Dr. Fleming in an early part of the *Illuminating Engineer* (Vol. I., Jan., 1908, p. 19), and he states that a consumption of 1·78 watts per candle-power was obtained. The advocates of the system, however, contend that this does not truly represent the value of the light because its diffuseness and low intrinsic brilliancy enable one to secure better results, as far as the eye is concerned, than photometrical experiments would suggest.

The Relative Costs of Different Illuminants.—Having described so many electrical illuminants I may, perhaps, be expected to give some idea of their relative costs as compared with gas lighting, &c. I may explain that I myself only regard Tables of this kind as of very general interest, because the actual decision in any practical case depends very largely upon the local conditions. This is brought out by a Table containing some results of Monsieur Blondel in a paper to which I have previously referred.

You will also see that the relative costs of gas and of electricity can vary very greatly, even when lamps of the same type are considered.

Cost of Gas and Electric Lamps.

(Assuming Gas Costs 0·2 Fr. per cubic metre, Electricity 0·7 Fr. per KW. hours.)

	Incandescent Gas.		Incandescent electric lamps. Carbon. 32 C.P. for 300 hours.		Incandescent electric lamps. Tungsten. 32 C.P. for 1000 hours.	
	Upright.	Inverted.	110 volt.	220 volt.	110 volt.	220 volt.
	Litres.	Litres.	Watts.	Watts.	Watts.	Watts.
Hourly consumption in watt-hours or litres	80	80	100	100	35	45
	Francs.	Francs.	Francs.	Francs.	Francs.	Francs.
Corresponding cost in francs	0·016	0·016	0·07	0·084	0·0245	0·0315
Cost of renewals per hour	0·0025	0·004	0·0017	0·003	0·0037	0·0062
Total cost of lighting per hour	0·0185	0·020	0·072	0·087	0·028	0·038
Mean Sph. C.P.	55	50	28	28	28	28
Cost per Mean Sph. C.P. per hour	0·00032	0·00040	0·00258	0·031	0·010	0·0136

Assuming cost of gas 0·10 Fr. per cubic metre, electricity 0·10 Fr. per KW. hours.

Cost of gas consumed	0·008	0·008	0·01	0·011	0·0035	0·0045
Total cost, including renewals	0·0105	0·012	0·012	0·014	0·0072	0·0107
Cost per Mean Sph. C.P. per hour	0·00019	0·00024	0·00043	0·0005	0·00026	0·00038

Formula enabling one to calculate running costs of electric lamps:

$$C = \frac{p}{TL_0} + \frac{p'W}{1000}$$

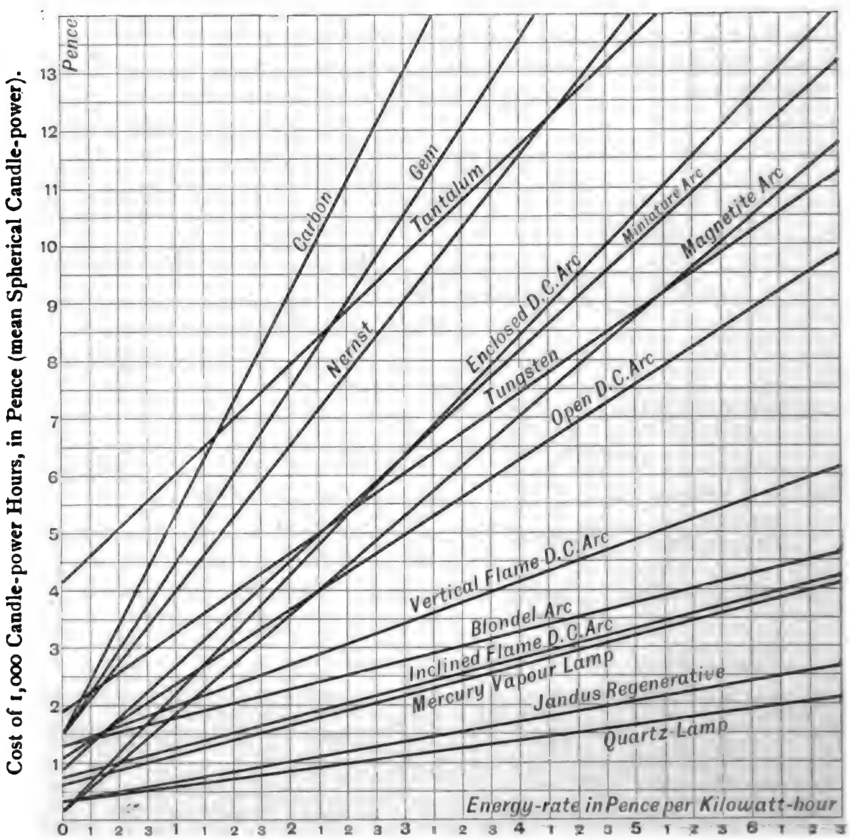
where p = Cost of lamp. L_0 = Mean Sph. C.P.
p' = Cost per KW. of electrical energy. T = Life before lamp is discarded.
W = Watt per Mean Sph. C.P.

(M. Blondel, Congrès de Marseille, 1908.)

Fig. 16 connects the cost of various electrical illuminants with various costs of electrical energy as given by Wohlauer. (See *Illuminating Engineer*, Vol. I., p. 663.)

I may explain the distinction between the terms "phosphorescence" and "fluorescence" that I have just used. By the latter we usually understand the degradation of

FIG. 16.



COMPARATIVE COST OF THE VARIOUS ILLUMINANTS. A. A. WOHLAUER. *The Electrical World* (N.Y.).

The cost of renewal and maintenance is taken as $\frac{P \times 1000}{l \times L_s}$, where L_s means the mean spherical candle-power.

l, life of *lamp* in the case of incandescent lamps; *glower* in the case of Nernst lamps; *electrode* in the case of arc lamps; *vapour-tube* in the case of vapour-tube lamps.

P, price of *bulb* in the case of incandescent lamps; *renewal of glower and ballast* in the case of Nernst lamps; renewal of *electrodes* and *trimming* for arc lamps; *tube* for vapour lamps.

OTHER METHODS OF GENERATING LIGHT—PHOSPHORESCENCE AND FLUORESCENCE.

There remains one conceivable method of generating lighting which many of you may consider fanciful, but which, nevertheless, seems to me to possess great scientific possibilities, and, indeed, has been carried to wonderful perfection for certain purposes by Mr. Hammer in the United States and others. I allude to the phenomena of phosphorescence and fluorescence.

ultra-violet into visible light energy which takes place only while the stimulus is applied.

Phosphorescence, on the other hand, is usually taken to indicate an effect of this kind which continues after the stimulus is removed, so that we may excite a phosphorescent substance, and subsequently use the light that continues to be emitted.

Mr. A. C. Cossor has kindly arranged for the exhibition of a few experiments illustrating these phenomena. Here, for instance, are

some specimens of Willemite, which fluoresce under the rays of the Uviol tube. A still more interesting example of induced fluorescence is the effect of only 5 milligrams of radium in exciting quite a large piece of this substance. Now that the lights are turned down you will observe a distinct green luminous appearance of the Willemite, which appears as the radium is brought near, and disappears again as it is withdrawn.

It has been proposed to modify the spectrum of the quartz mercury lamp by painting the tube with fluorescent substances.

Professor S. P. Langley, who studied the nature of the phosphorescent light from a firefly, characterised it as the most efficient illuminant in existence, and the researches of Nichols and others suggest that for some reason or other phosphorescent materials almost invariably contain the greater part of their radiation within the visible spectrum. It may be that these researches will lead to new methods of illumination in the future.

GAS.

INTRODUCTION.

In dealing with the programme of my lecture on gas, I find myself again confronted with a subject which is extremely vast, and to many aspects of which separate and exhaustive Cantor lectures have been devoted by my predecessors.

For instance, Professor Vivian Lewes alone has dwelt on the practical aspects of gas lighting, the theory of the incandescent mantle, and other allied subjects, at great length, and I should like to refer those of you who wish to receive fuller details on these points, to the original lectures.

I may, however, make clear at the very beginning of this lecture, that I propose to restrict myself entirely to gas lighting proper, and not to deal with generating problems and distribution, except in so far as they are immediately connected with illumination. I shall not, therefore, trouble you with an exhaustive description of the processes by which gas is produced, nor with particulars of the composition of ordinary town gas, water gas, producer gas, or any of the other varieties of gas that have played a more or less direct part in gas lighting.

HISTORICAL.

It may, however, be interesting to give a few particulars of the early development of gas lighting in Great Britain and other countries, and in this connection I should like to refer you to an interesting article by Dr. R. Böhm (*Illuminating Engineer*, February, 1908), and also to some remarks on this subject in Mr. W. H. Y. Webber's book on "Town" gas.

One of the very earliest records of the manufacture and storage of illuminating gas, is that in the Transactions of the Royal Society for 1739, when the experiments of the Rev. Dr. John Clayton on this subject were communicated.

Dr. Dundonald, it is also known, carried out some experiments on the subject in 1787, but William Murdoch, who took up the subject a few years later, and who lighted his factory in Redruth in 1792, and his factory at Soho, Birmingham, in 1802, is regarded as in many respects the father of the industry. Subsequently the Chartered Company was formed in London in 1810, by Winzler, a Moravian, who had become interested in the subject, and travelled to London to give his ideas practical shape, and in 1813, Westminster Bridge was lighted by gas for the first time.

A name which, like that of Murdoch, will always be inseparably connected with the early beginning of the gas industry in this country, is that of Mr. Samuel Clegg, a pupil of his, who afterwards carried out his work, in connection with the Chartered Company, with indomitable perseverance and ingenuity.

England can, therefore, claim to have done much of the early pioneering work in gas lighting, though similar work had been done in Paris, by Lebon, in 1784, and in Germany even earlier; it was not, however, until the 19th September, 1827, that the famous street of Unter den Linden, in Berlin, was lighted by gas.

It has often been said that nothing was so stimulating to the development of gas as the rise of electricity. On the other hand, electrical engineers (who have certainly had sufficiently great initial difficulties of their own to overcome) ought to remember with gratitude the work of the gas companies in overcoming early prejudices, and paving the way for their future efforts. At the time when the Chartered Gas Company was formed, the idea of an illuminant transmitted to a distance was one that the general public found it impossible to conceive, and Clegg, in his early efforts, was hampered by an incredible degree of misunderstanding as to what lighting by gas really consisted of. In addition, he had to face the difficulties of securing materials, and to devise means of overcoming unexpected obstacles.

For instance, Clegg is said to have been at one time unable to obtain the necessary metal piping, and to have had recourse to strings of old musket barrels screwed together.

For a time, there was no means of measuring the gas supplied; consumers hired their lights at a yearly rental, and there was much misunderstanding and dissatisfaction. The early difficulties of gas in London were accentuated by the existence of several competing companies, who apparently were not above exceedingly unscrupulous tactics in competing with one another. Mr. Webber, for instance, relates how one company would occasionally instal a show lamp, free of charge, in order to attract a consumer, and were not above attaching it to the mains of a rival.

Actions like these led to a species of guerilla warfare between the competing companies. Gangs of navvies were employed for offensive and protective purposes, and the streets were in an almost continuous state of upheaval owing to their exertions. Eventually, however, an amalgamation of these various companies was effected, and the supply of gas began to resemble more closely the conditions of the present day.

Early Type of Burners.

The earliest method of burning gas was, of course, by the use of the so-called flat flame burners, which we should now consider extremely inefficient, for they yielded only about two to three candle-power per cubic foot of gas, even under the most favourable conditions. Of course, however, it must be remembered that gas, unlike electricity, may vary in quality in each district. For instance, the Act of 1860 prescribed that the town gas burned under certain specified conditions in a standard Argand burner should give 15 candle-power; but the rich local cannel coal in Scotland was capable of yielding as much as 20 or even more candle-power.

Similar results could, of course, be obtained by enriching the gas by the addition of some volatile hydrocarbon. For instance, in the "albo-carbon" burner, the gas must pass over naphthalene, which presently became volatile in the heat of the flame, and mixing with the gas emerging from the burner considerably improved its quality. It was, however, but a cumbrous device.

Somewhat better results than those mentioned above could also be obtained from the Argand burner, but this again occasioned a more delicate and unsteady flame. Yet another early improvement was in the direction of the so-called regenerative lamps, in which the gas was heated by the flame before it passed into the burner, and a greater flame temperature and improved candle-power were obtained as a consequence. The Wenham lamp depended on this principle.

Table of Efficiencies of Various Burners.
(W. Grafton, Practical Gasfitting.)

Type of Burner.	Specific Consumption. (Candle power per cubic foot of gas per hour.)
Flat-flame, Batswing..	4–6·1 (with 30 candle gas)
Ordinary Argand	2 : 7–2·9 (with 16 candle gas)
Standard Argand	3 : 2–3·35 (with 16 candle gas)
Albo-Carbon light	5–6
Regenerative lamps ..	10–12
Acetylene	generally 35, best conditions 48.
Welsbach "C" 1893 burners	12–14
Welsbach "C" 1898 burners............	19–23·4
Welsbach "C" Bansept	18–20
Added:—	
High-pressure incandescent	40–50
Keith high-pressure Light	60–70

The Coming of the Incandescent Mantle.

It was, however, not until the introduction of the incandescent mantle and the Bunsen burner that any really great progress seemed possible.

I need not enter in any detail into the wonderful researches of Auer Von Welsbach. The lectures of Prof. Vivian Lewes before this Society have given us an insight into the theory of the mantle, as far as it was known at the time of these lectures.

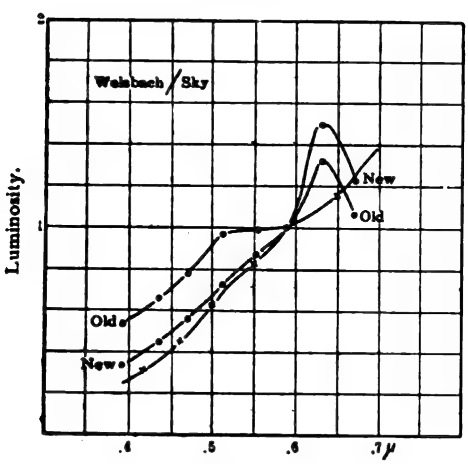
Another instructive paper dealing with the theory of the radiation of the mantle in some detail, was that of Professor Rubens, before the British Association, a few years ago.

It has been suggested that the effect is due to pure thermal incandescence, and that the temperature of the mantle is far hotter than that of the Bunsen flame. Again, it has been supposed that catalytic action takes place among the oxides which are present in the mantle. It is also known that the rare earths are peculiarly capable of showing luminescence, and that only when small impurities are present does this luminescence take place, and lastly, it has been pointed out that the Bunsen

flame is rich in the ultra-violet rays that are supposed to call this luminescence into play. Yet it does not appear that we have arrived at a complete understanding regarding the action of the mantle at the present day.

Colour of Light from Mantles.—Even after this discovery, however, the mantle was far from perfect. Its luminosity deteriorated very quickly, and the quality of the light was of an unpleasant greenish colour. To-day these drawbacks have been very largely removed. The following figure for instance,

FIG. 17.



SHOWING SELECTIVE RADIATION AND PECULIAR COLOUR OF OLD TYPES AND MANTLES.

(Nichols, Trans. Illum. Eng. Soc. New York, May, 1908.)

shows the results of Nichols, for mantles of the present day compared with old-fashioned ones as regards the colour of the light produced. It will be seen that the more old-fashioned mantles yielded a spectrum showing considerable selective radiation, and a corresponding deviation from daylight, which is much improved in the later varieties.

Durability of Mantles.—Other incidental difficulties have been the tendency of mantles to burn into such a shape as not to be completely encircled by the flame.

In this connection, it is somewhat interesting to observe a recent device consisting of an infusible conical core, which is placed over the crutch of an incandescent mantle, and is said to guide the flame on to the mantle itself, and to result in an improvement of 20 per cent. in efficiency. [Since writing the above, I observe that Mr. C. Forshaw, in a paper read at the annual meeting of the Gas Institute this year, describes some experiences of cores of this kind, which are also satisfactory.]

After referring to the other qualities of mantles of importance, perhaps I may be expected to give some details of life tests. I may, therefore, refer to some tests undertaken about two years ago by Böhm (*Das Gasgluhlicht*, 1905), according to which you will see that relatively efficient results could apparently even then be obtained for 300 to 600 hours of life. (Fig. 18, p. 784.)

As in the case of electric glow lamps, however, one feels that practical conditions are widely different from those prevailing in laboratory tests. Makers of lamps in England, at the present day, feel that one of their chief needs is a really good mantle, those in even ordinary burners requiring renewal on the average every 200 hours. There are so many respects in which a laboratory test is exceptionally favourable to the performances of mantles. For instance, reference need hardly be made to the effect of even a slight vibration; this, it is true, has been reduced by the many ingenious anti-vibration devices which Mr. George Helps, of Nuneaton, Messrs. Parkinson and Cowan, and others, have devised. In addition, as Mr. Wild has recently shown (*Journal of Gas Lighting*, April 2nd, 1907; *Illuminating Engineer*, 1908, p. 783) the results from any mantle depend very greatly on such factors as the pressure and quality of gas available, the type of chimney used, and the adjustment of the proportions of gas and air. The variations in these conditions really make it essential for a gasfitter to adjust each burner to suit the local requirements. (Fig. 19, p. 785.)

In addition, I need hardly say that the occasional blowing out of accumulated dust in the burner, is necessary. In public lighting, too, even the best lamps are not always unaffected by gales of wind, which have a very important influence on the question of renewal. Altogether it is highly probable that the termination of life of a mantle is usually determined by breakage, rather than diminution of candle-power, just as is not infrequently found to be the case for metallic filament lamps. Probably too, as in this case, variations in pressure are not without influence. It has even been suggested that a governor ought to be installed at the meter of each and every consumer.

New Types of Mantles.—Besides the other improvements referred to in mantles, notable advances in their durability have lately been achieved. The introduction of the Ramie

mantle about 1898 was regarded as a great advance.

Two years ago a new departure in incandescent lighting was introduced by the Plaissetty Company in the form of the Monarch soft or non-incinerated mantle. The advantages of a soft mantle for convenience in packing and immunity in handling and transit are obvious. The greatest danger to inverted incinerated mantles, namely, the risk of fracture at the ring in packing, is claimed to be avoided. But the greatest advantage offered by the soft mantle, it is said, is the latitude which it gives in burner development. By the use of a non-incinerated fabric, shapes and sizes can be obtained, which are practically impossible in an incinerated form.

For a soft mantle certain conditions must be satisfied :—

1. The illuminating salts should be compact and in oxide form.

2. The fabric should contain the minimum of cellulose.

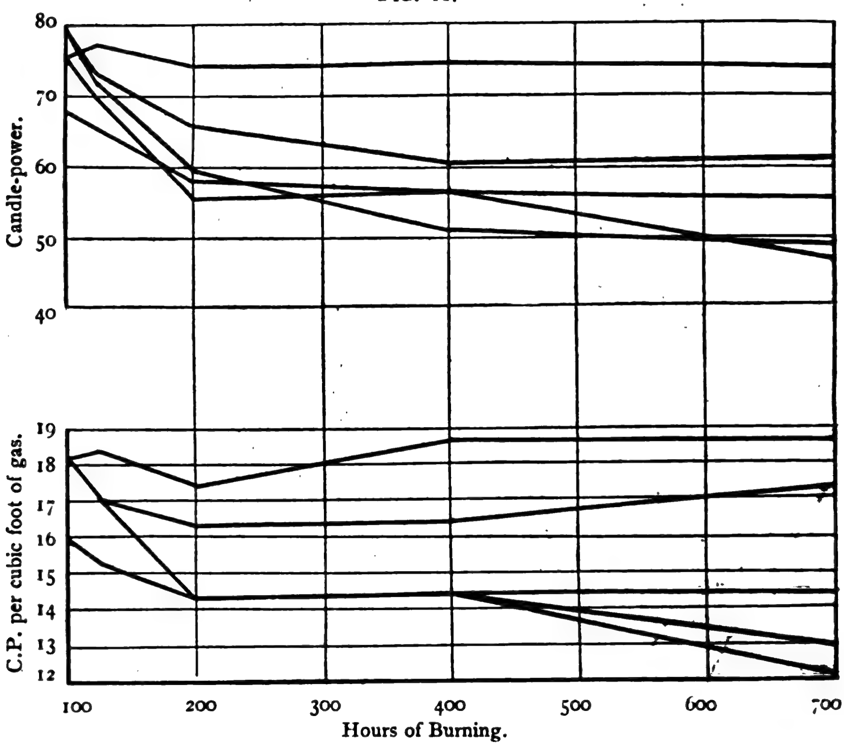
3. The fabric should be shaped and the cellulose easily burnt out.

Another type of artificial silk mantle recently brought out, that of the Cerofirm Company, is stated by Böhm (*Illum. Eng.*, June, 1909), to be a great advance, having like the Plaissetty mantles, good elastic properties, together with improved efficiency and a whiter quality of light than was obtained previously. This is said to be due largely to the special nature of the impregnating salts used, which, after burning off, leave a very fine and durable surface of oxide behind.

Next I may mention an interesting new development, namely, the Hella Bushlight, which, as you will see by the example kindly supplied here to-day, consists not of a mantle but of a bundle of rods composed of suitable rare earths. (See Patents Nos. 3785 and 9622 of 1908.)

The great claim made for this system is, that, while yielding an efficiency approaching that of ordinary mantles, the illuminating apparatus itself is exceptionally durable.

FIG. 18.



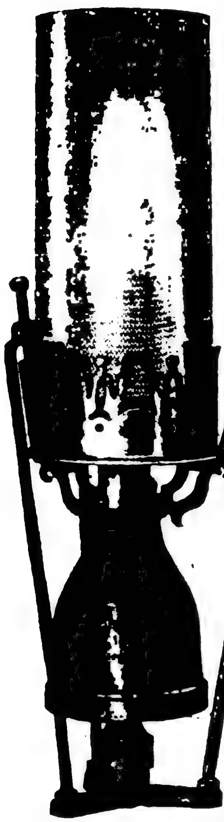
LIFE-CURVES OF INCANDESCENT MANTLES (Böhm).

DEVELOPMENT OF THE BUNSEN BURNER.

I may now make some reference to the development of the Bunsen burner, the other important factor in the incandescent light.

The efficiency yielded by an incandescent mantle depends to a very large extent on the flame temperature obtainable, and the possibility of securing perfect combustion of the gas supplied. The original Bunsen burner only consumed about one part of gas to two of air, whereas the average kind of town gas requires about 5½ to one for complete combustion. By suitably designing the burner we can make a

Fig. 19.



Type of Anti-Vibration Holder. (Messrs. Parkinson and Cowan.)

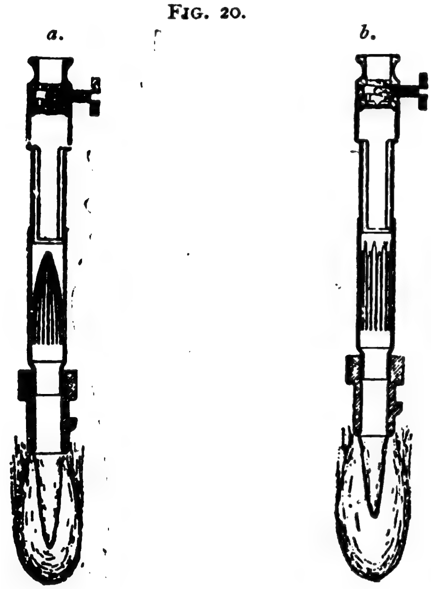
mixture of about one of gas to three of air, but any attempt to produce a poorer mixture than this causes the flame to light back, if special provision is not made to avoid it. The device introduced into the ordinary incandescent burner to avoid this possibility merely consisted of a wire gauze acting on the principle of the Davy safety lamp.

Other details in the burner have been devised for the purpose of securing an intimate mixture of gas and air. For instance, in the Welsbach-Kern burner, a tapering cylinder is added to the burner in order to give the gas and air opportunity of mixing completely, and a peculiar twisted head is fitted with the object of producing a swirling motion of the mixture as it appears at the nipple and is burned.

Inverted Burners.

Within the last few years a very great advance has been effected by the introduction of inverted burners. The early experiences of this burner were not entirely satisfactory, and there were many initial difficulties to overcome—so much so that even in 1906 there were many who doubted whether the burner would ever become a commercial success. For

Fig. 20.



a. Sketch of Inverted Bunsen Flame when first lighted, thermostatically controlled.

b. Sketch of Inverted Bunsen Flame after burning ten minutes, thermostatically controlled.

(Whitaker, Trans. Ill. Eng. Soc., New York, Dec., 1907.)

instance, the tendency to light back appeared to be accentuated, there was a tendency to produce a hissing noise, and the conduction of heat upwards to the fitting caused it to wear out very rapidly. Most of these difficulties were got over by suitable designing of the mixing-chamber, &c., though other special devices are necessary for the solution of one theoretical difficulty, namely, the fact that the burner, after burning say ten minutes, becomes so much hotter as a whole than it was originally, as to call for slight adjustment of

proportions of gas and air in order to obtain the most perfect results.

A very ingenious method of controlling the proportions of gas and air, and of getting over this difficulty has been described by Litle and Whittaker (Trans-Illuminating Eng. Soc., New York, 1907); it involves a special thermopile-controlled valve, by means of which the proportions of gas and air necessary for complete combustion are automatically regulated. (Fig. 20, p. 785.)

In passing it is interesting to note that Clegg, very early in the history of gas lighting, devised a self-closing burner with thermostatic

FIG. 21.

action for the purpose of shutting off the gas whenever the flame became accidentally extinguished in order to satisfy the fire insurance authorities (Webber, "Town Gas and its Uses," page 28).

The inverted incandescent mantle, however, is of course to-day an accepted fact, and possesses very distinct merits. For instance, apart from improved efficiency, the attachment of the mantle by means of its entire rim is distinctly preferable to the system characteristic of the upright burner of merely hanging the mantle on a crutch.

I cannot find time to refer to the many devices by which the difficulties inherent in inverted burners have been overcome. A few examples of such devices are exhibited here to-night. For instance, the Hands cooled burner is provided with deflecting wings which conduct the heat away and prevent discolouration of the fitting. The principal advantage claimed for this burner is that its winged deflections serve the purpose of preventing discolouration of fittings, and keep the head of the burner cool. In addition, the air and gas

FIG. 22.

FIG. 23.

TYPES OF BLAND INVERTED BURNERS.

adjustment is claimed to be exceptionally easy, the head always remaining perfectly cool after it has been burning for hours.

A test, I am informed, has recently been made by one of the largest gas companies in this country, according to which a burner was fitted on a polished brass adapter and was left burning from 7 a.m. until 10 p.m. for a period of six weeks. At the end of that time the

finish of the adapter was found to be not discoloured or injured in any way whatever. (Figs. 22, 23.)

In the Bland burners, again, a patent anti-lighting-back arrangement is provided, and there is also a special carrier to grip and support the mantle, which is not attached to the actual burner, with, it is claimed, the result that the life of the mantle is prolonged, because the shocks occasionally administered to the burner are not communicated to the mantle directly.

FIG. 24.

OMAR INVERTED BURNER. (Moffat.)

Other modern types of inverted burners on exhibition are the Omar and Mascot types of Messrs. Moffats, Limited. One essential detail of these burners is the use of a perforated outer metal casing with which the products of combustion are not allowed to come in contact owing to the use of an opal glass collar. In this way it is claimed the burner retains its original appearance for months without becoming visibly discoloured or tarnished.

In the Mascot burner, in addition, the air is slightly warmed before reaching the mixing chamber, some of the waste heat of the burner being utilised for this end. This serves the double purpose of producing a good velocity of the gas and air mixture and favourable conditions of combustion, and at the same time of cooling the parts of the burner over which the mixture passes and preventing consequent discolouration.

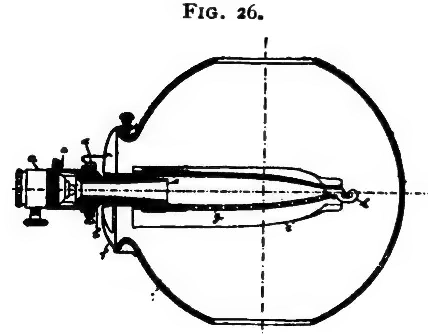
In addition, inverted mantles have a smaller and more compact form, and seem not to deteriorate and split so readily. The advan-

FIG. 25.

MASCOT INVERTED BURNER. (Moffat.)

tage on which most stress has been laid, however, lies in the improved distribution of light, the maximum candle-power being usually obtained in a downward direction. The exact nature of the distribution curve

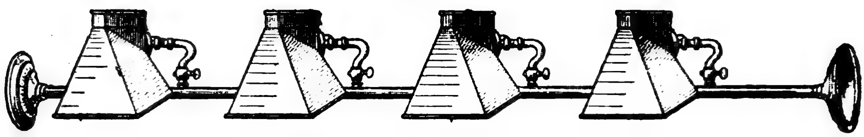
FIG. 26.



"TUBUS" HORIZONTAL BURNER.

depends to some extent on the shape of the burner. They may be longer than they are broad, and it is then possible to obtain a good downward component, and yet at the same time stronger intensity at a downward angle;

FIG. 27.



"TUBUS" BURNERS AS ARRANGED FOR SHOP LIGHTING.

this, of course, is the nature of curve we mainly desire for street lighting, and inverted mantles, as will be mentioned later, have recently been applied for this purpose, with success in Berlin, and more recently still in Fleet-street, London.

It may be new to some of you to learn that a firm in Berlin manufacture a type of burner with a mantle in a horizontal position (Czudnochowski, *Illuminating Engineer*, Vol. 1., 1908, p. 582). It is called the Tubus burner, and is claimed to be specially suitable for the illumination of shop windows, where a strong downward component is desired. (Figs. 26, 27.)

A SUNSET ON MATHERAN.

BY SIR GEORGE BIRDWOOD, M.D., K.C.I.E., LL.D.

This ethnographical vignette was originally a footnote on the name of the late Honourable Jugonnathjee Sunkersett, of Bombay, in my Introduction to Mr. Talyeikhan's "Representative Men of India" [W. and H. Allen, 1880]; and is here reproduced, with my latest emendations, as supplementary to the account given by me in the issues of our *Journal* of October 11th, and November 29th, 1907, of the "Burst of the Monsoon" in Western India.

The idolatry of the Hindus is a moot point with most Englishmen, and with Europeans generally. I may not allow myself to enlarge on the topic here, nor is it necessary, as the following anecdote will suffice to indicate my own conclusions on the subject, impressed on me as they have been by many similar experiences of my life in Bombay.

The late Hon. Jugonnathjee Sunkersett was an orthodox Hindu, of the most uncompromising temper; but owing to some service I was able to render him in 1857, I enjoyed his entire confidence; and there is no man in whom I have ever taken a deeper personal interest, or for whom I could possibly have a more affectionate and steadfast regard. We were so intimate together that he would freely admit me to his presence while engaged in his private devotions with his domestic Brahman; only, on such occasions, I sat down just beyond the threshold of the door leading from his bedroom—in his Girgaum house—into the room in which he worshipped the ancestors of his family, and the greater deities of the official Brahmanic Pantheon; and seated there opposite me, stripped to the skin, with the officiating Brahman, and the images of his gods before him, and all the utensils of idolatrous worship, he would explain every detail of it to me as it proceeded.

Now, the great longing of his heart was that before he should see death, he might be blessed with the birth of a son to his only son, Venayekrow Jugonnathjee, familiarly called Rowjee. Years had followed years, but only girls had been born to Rowjee, and the birth of a man child began to appear hopeless. Jugonnathjee Sunkersett himself had visited every shrine in Western India, praying for a grandson, and had even extended his pilgrimages for the purpose to Benares, and I believe to Muttra and Hardwar; and he never saw me without introducing the subject into our conversation. Such was the state of matters when, being on a visit to the hill station of Matheran, and curious to ascertain the ritual of the orgiastic worship said to be enacted there by the outcast jungle tribes—chiefly cow-herds, and cutch [extract of *Acacia Catechu*, W. and A.] collectors—before the uncouth altar to "Pisnath Deo,"* [*i.e.*, Pasha-Naths, 'Pasture Lord'] in the dark grove of evergreen ironwood trees [*Anjun*, *Memecylon edule*, Rox.], at "Danger Point," on the west side of the hill, just above and to the left of "The Waterfall," I concealed myself for the purpose behind a rent in the wall of piled blocks of basalt enclosing the grove. A number of poor, abject creatures had gathered there in the dread gloom, and were about to kill a scared-looking cock, when suddenly who should come from opposite my hiding place, trotting straight into the grove, but the Hon. Jugonnathjee Sunkersett, followed by a mounted orderly (for he was a Member of the Legislative Council of Bombay), and two running peons. I thought at first that he was there, like myself, from curiosity, and was about to go forward to greet him; but the peons immediately placed themselves at the head of his horse, and he himself dismounted, and stepped up before the dreary and degraded shrine. He was a man of the Scytho-

* This is one of, if not, indeed, the most fascinating of all the words in the whole cycle of verbal affinities among the pan-Aryan languages: going back to the Sanskrit *pa* "protector," as in Gopala "the Cowherd," the Persian Padshad "Lord sovereign;" the Greek δεσπότης, "lord;" πάστη, "food," and παστός, "porridge," and πανός "bread;" Πάν, Pan; the Latin "pater" father, "patria" native country, "patronus" patron, "pastura" pasture, "pabulum" fodder, "panis" bread, Pales, Penates, and Palatinus [Mons]: and the English, (1) through German, Palgrave, foster, father; (2) through Latin by French, appanage, pantry, pasty, pattypan: (3) through Latin direct, see above, and innumerable other words; (4) through Greek, panic, patronymic, patriarch; and (5) through Persian, pasha, bashaw, bezoar-stone, *i.e.*, Pad-zahar "Lord over poison."

Aryan type, and of splendid appearance, from his shoulders upwards higher, wherever he was, than the people about him; and there he stood, in the light of a sloping ray of the declining sun that stole in between the dark trunks of the ironwood trees, long-robed, and high-turbaned, and girded round his loins, a living presentment of the "magnificent son of Akbar." But in another instant he was wringing his hands in an agony of prayer, with the burning tears streaming down his handsome, massive, but now deeply seared face; his wan, beseeching eyes looking right up towards the heavens high above that closely grown canopy of deep green, polished *Anjuni* leaves. Feeling myself to be the spectator of a scene I certainly ought not to witness, I stealthily withdrew from the spot, strolling on leisurely toward the bazaar. I had not gone on my way more than a quarter of an hour when, just before reaching the "Clarendon" Hotel, I became aware of the clatter of galloping horses approaching from behind me, and presently I heard my name being joyfully shouted out after me. Almost before I could turn round, the Hon. Jugonnathjee Sunkersett and his escort were upon me, his face lighted up in the deep-toned brilliance of the setting sun, with the most proudly radiant look of gladness.

"Oh, Settjee," I said, responsively to his mood, "you have good hope of a grandson."

"Indeed, yes," he replied, "it is just what I wanted to tell you, Birdwood."

"But," I resumed, "what solid ground have you for your assurance?"

His answer was: "Solid ground of assurance! Why God Himself has told me!"

I was astounded by the reply, and—remembering what I had secretly seen—could say nothing for my emotion; and I left him to talk on awhile like a happy child, until by devious paths—but as much as possible still pressing eastward—we at length arrived at "Alexander (now called Alexandra) Point." This Point is a little more than a mile east from "Danger Point," and commands the whole of the picturesque vale of the Chouk river, trending away south-westward, between the main mass of Matheran and its treeless north eastern spur, called, from its flinty surface, Garbut.

The twilight had now passed in the valley below us into a purple tint, rising higher and higher to the great grove [Ram Bagh, "God's Garden"] of wide-spreading mangoes, and towering *Jambools* [*Syzygium Jambolanum*, W. and A.], lordliest foliage of the woodlands of Western India, and the other fine forest trees hanging upon the east side of the hill, half way down the steep, and thread-like, rock-cut and splintered track of the old zig-zag ghat road to Chouk. The ardent purple tint had welled up to this level. Above it the umbrageous top of Matheran was flushed with the clear reflection from the refulgent orange light yet aglow in the west, turning all its exuberant leafage to a rich mystic green, of gem-like illumination. In the advancing night, thus momentarily irradiated with the still enfolded brightness of departing day, the whole enchanted mountain and valley seemed as if filled with the visible glory of over-shadowing Deity; and Sunkersett at once became silent before the profoundly solemnising, wondrous scene. Silently he watched the primitive hill-men returning by the precipitous and slippery Chouk ghat road to their scattered huts in the rapidly darkening depths of the valley below; each one, as he advanced to the head of the dangerous descent, bending lowly down, and reverently, towards the sun's far sunken flame:—

"Through Ages hymned by Hindu devotee."

The tumult of his soul was hushed, and at the last—as we turned to retrace our steps homeward—from out its depths he thoughtfully, and in his frequent oracular manner, observed: "Yes, just as our five fingers go back to one and the same arm, so all religions go back to one and the same God." Thus closed what was to prove an ever memorable day with him, and with me, for, remarkable to relate, with the completion of nine months from that date, a grandson, the deferred hope of all the years of his prime, was born to Jugonnathjee Sunkersett. The patient heavens had heard his prayer, and now their answer was not weak. And then, the great hope of his life having been fulfilled, straightway a change came over him. He was a man of strenuous energy, the most masterful natural capacity, and undisguised ambition and pride. He was not only the leader of the Hindus of Bombay, but after the death of the great Sir Jamsetjee Jejeebhoy,* of the whole Native community. But now he laid aside all worldliness, and unobtrusively and determinedly submitted himself to the great longing for death that seemed to have taken complete possession of him; saying, on my once venturing to remonstrate with him for thus yielding himself up to die, and, in so saying, using almost the very words of the Greek writer:—"It is not difficult, Birdwood, but easy; for the road is not crooked, but straight; and not up and then down, but all downward; and an unfearing man may walk it blindfold." No! He had seen the salvation of God, as sought by himself; and now all he desired was to depart in peace.

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* How great they all were, the Bombay Parsis of that golden prime of their glory!—Cursetjee, the second Jamsetjee Jejeebhoy, the "perfect gentleman," his brother Rustomjee, the absolute incarnation of their great father's philanthropy, but not of his genius in business; C. F. Paruk; C. N. and C. R. and B. F.. and D. F. and M. F. and M. H. Cama ["the six Camajees"]; Cowasjee Jehanghir; Nusserwanjee M. Petit; Byramjee Jejeebhoy; C. M. Limjee: A. C. and H. C. Dady; D. P. and H. B. Wadia; F. N. Patel; D. F. Karaka, the historian of the Indian Parsis; Manockjee Cursetjee; Nowrojee Furdonjee; Sorabjee Shapoorjee; S. J. Sett,—all dead men now;—and brightest and best of all the sons of that morning of fresh-gathered greatness and glory, Dabadhai Naoroji, who still lives, through a third generation, in the all-cheering light of his long life of fearless and unfailing uprightness and devotion in the highest service of his exiled race and their foster country.

Soon afterward he died; and then they made very great burning for him. I thought it would have given me a cruel shock; but it was attended with none of the horrors—the awful reverberatory furnace, the repulsive, factory-like chimney, and all the soulless mechanism—of cremation in Europe. Except that milk was used instead of wine, the ritual was essentially that observed by Homer in the burial of Patroclus; and, so far from being pained, when it was all over, and I looked up into the clear and brilliant heavens above, I was soothed by the reflection that no taint of earthly corruption would ever be associated with the memory of my friend, for all that had been mortal of him was now part of the vital air and the cheering sunshine around and about me; a consideration naturally suggesting the inspiring hope that if human self-consciousness was indeed immortal, the freed spirit of Jugonnathjee Sunkersett was already with the "Father of Lights," the "Ancient of (undying) Days." It is impossible not to be deeply interested in such men, and when you know them for what they really are, not to have the sincerest friendship and admiration for them. As for their idolatry, my whole mind was changed toward it after that answer given by Jugonnathjee Sunkersett near the "Clarendon" Hotel:—"Solid ground of assurance! Why, God Himself has told me!" And this out of the mouth of a man I had just seen in that wizard wood of *Anjun* trees, praying, apparently, to a hideous heap of foully-ruddled and stinking idol stones!

Henceforward I knew that there were not many gods of human worship, but one God only, who was polyonomous and polymorphous, being figured and named according to the variety of the outward condition of things, ever changing and everywhere different, and unceasingly modifying our inward conceptions of them. We all are His offspring: and every place is His temple.

THE TUSCAN LACE INDUSTRY.

The lace industry in Tuscany was revived about thirty years ago by some manufacturers from Liguria, who had for some time the monopoly of the trade in Florence. These pioneers of the newly-revived industry had many serious difficulties to overcome. In the beginning the principal difficulty was the inability to secure women labourers. Straw-braiding was the most profitable at that time in Tuscany, and enabled the women to occupy all their spare time plaiting straw, while attending casually to their household duties. Straw-plaiting is like knitting, as it can be accomplished by the plaiter almost automatically while walking about and attending to other matters. Naturally, so agreeable an occupation was preferred to lace-making. However, the gradual decline of the straw-plaiting industry, owing to competition in production from other countries, reduced wages so materially that the women were finally compelled to take up a more profitable occupation. In the meantime various Tuscan ladies became deeply interested in the condition of these people, now deprived of their former occupation of straw-plaiting, and through personal and financial aid, taught many women the reviving trade of lace making. According to the American Consul at Florence, a school was opened consisting of some twenty pupils, under the patronage of Contessa Gabriella Spalletti-Rasponi, and having secured the co-operation of Francesco Navone of Florence, their work soon found a market. Signor Navone greatly appreciated the beautiful models which were presented for his inspection, models which had been secured from old heirlooms by the patroness, and promptly undertook the management of the school. He secured designs of the best patterns in the museums of Europe and has since had them carefully copied by the clever Tuscan women. The old "filet" lace has been particularly successful, and at the time of the last exhibition at Paris some reproductions of old "Italian filet" were exhibited with such success that the making of "filet" is now a speciality. From Florence this method of lace-making has been introduced into Venice and also into France, and the lace is now manufactured in both places on a large scale. It is particularly in request for the adornment of table linen, curtains, bed linen, pillows, &c., and the finest qualities in gowns and underclothing. Another school has also been opened in Tuscany under the patronage of Contessa Spalletti-Rasponi for the manufacture of linen embroideries. This is also under the management of Signor Navone, who has combined the Tuscan lace and embroideries most artistically. Both of these schools have prospered so remarkably within the last ten years that they now employ several hundred working women. The work is given to the women under contract, is made at home, and when finished is brought back to the school, where it is promptly paid for in accordance with an agreement previously settled. The women themselves have arranged a co-operative corporation with a capital of about £1,000, which aims to provide for the relief of the sick members, medical attendances, medicines, and to alleviate the poverty of the less fortunate and of the needy; also a provident bank has been recently opened through the payment of small sums by each working woman and 10 per cent. on the value of the work executed. Besides these two schools lace is manufactured in most of the principal towns of Tuscany, the work being promoted and encouraged by the Society of Women's Industries and by many charitable ladies. The convents also produce much beautiful lace and many simple varieties are made by the peasants. The output of this industry is for the most part sold to foreign visitors, especially Americans, who are considered the best customers; also to dealers from France, Germany, and the United States, who in former times confined their purchases to Paris, London and Berlin, now send to Florence important orders. The industry continues to grow steadily.

THE LITHOGRAPHIC STONE INDUSTRY.

The business of quarrying, and preparing for market, of lithographic stones is carried on near Solenhofen, about forty-five miles south of Nuremberg, on the main railway line to Munich. The town is an unimportant one of about 1,300 inhabitants, the stone quarries being in the hills at the back of the town, at a level of some 1,500 feet above the sea. So far as is now known, the area in which these stones are found is not more than four or five miles long by two or three miles wide. In this limited area quarrying has been carried on for more than a century, and from it practically the world's supply of lithographic stones has been obtained. The stone is a species of compact limestone of peculiar texture, and of a yellowish grey or bluish grey colour, hard bluish stones being the more valuable. It is found in layers, varying in thickness from half an inch, or even less, up to six or seven inches. The layers extend from near the surface of the ground to a depth of seventy-five or one hundred feet, or even more, and are apt to be much broken by fractures or seams, and layers of worthless rock and earth. The American Consul at Nuremberg says that in the best quarries not more than one-twelfth of the material removed is marketable stone, and much of this is of little value because of the small sizes in which it can be found clear of cracks or flaws. The quarrying is carried on by several different firms and by a company. About twelve hundred workmen are employed in the varions quarries and in the work of cutting and dressing the stone for market. The stones are lifted carefully from their position in the quarries in various marketable sizes, and are then carried to buildings near by. Here the surfaces—for some markets one, and for others both—are ground down, chiefly with coarse sand rubbed on by heavy machines, water being constantly applied during the process. One establishment has recently introduced a heavy machine fitted with a carborundum planer, which rapidly smoothes the surface of the stones as they are passed backwards and forwards under the planer. The stones are further smoothed by machinery and by hand, the edges being neatly trimmed and corners rounded. If the stones are six or seven inches thick when taken from the quarries as is sometimes the case, they are sawn through once by heavy saws fitted on the edges with diamonds, and worked by steam power. In recent years the thinner stones, which would break under the pressure to which they are subjected in printing, are, in some cases, securely cemented to other stone slabs, thus giving the requisite strength. It is a notable fact that the industry has never been a source of great profit to those engaged in it. The explanation is that the amount of dead work in the quarries is large, and the proportion of perfect stone of marketable size so small as to leave little margin of profit at the prices at which the stones are sold. It frequently happens that after a stone has been ground smooth, or perhaps been sawn through at considerable expense, a chalky vein, small pebbles, or other defects appear in the surface, greatly lessening its value. These defects become apparent when a damp sponge is passed over the surface of the stone. Those interested in the lithographic stone industry say that the demand for this product has not rapidly increased in recent years. At the present rate of quarrying they believe the supply at Solenhofen should last from one hundred to two hundred years, or even longer. The stones are at present exported to all civilised countries of the globe. France, Italy, the United Kingdom, and the United States are the largest importers, in the order named.

HOME INDUSTRIES.

Imprisonment for Debt.—The Report from the Select Committee on Debtors (Imprisonment) Bill which has just been issued is not likely to satisfy those who look upon the existing law as working monstrous injustice to the poor, or those who consider that in the interest of the poor themselves its repeal is not desirable. The Committee devoted most of their attention to a consideraton of the question of committals under Section 5 of the Debtors Act, 1869, and they find that, whilst modifications are desirable, the Act itself is beneficial. Indeed, they go so far as to say that "the law as it is appears useful and salutary, and its administration by judges and magistrates just." Elsewhere they speak of the "overwhelming advantages of procedure under the Debtors' Act," but they are constrained to admit that "it is being abused by certain classes of traders." The evidence shows that "there has been a great increase in the vendors of jewellery, expensive watches, and all sorts of publications on the terms of payment by instalments at prices often many times in excess of their market value." Here we get to the crux of the evil. The Report does not allude to it but the fact remains that much of the rubbish bought from tallymen and others by the wives of the labouring class is bought without the knowledge of the husband who, as often as not, is kept in ignorance not only of the transaction, but of subsequent county court proceedings, until they have reached the point where concealment is no longer possible, and the innocent man finds himself under an obligation to pay a sum of money he does not possess, and cannot borrow, or go to gaol. The Report recommends that the existing law shall be altered so as exclude creditors from making use of Section 5 of the Debtors' Act except in cases where their judgment debt has been obtained either for necessaries or for damages for torts. It is pointed out that the duty of deciding what are necessaries is one constantly performed by Judges in regard to infants, &c., and there is no reason to suppose that the Judges would be either unable or unwilling to perform it in cases of debt. The amendment of the existing Act in this particular should go far to rectify

the abuses now complained of. To abolish imprisonment for debt altogether would, in the opinion of the Committee, be unwise.

The Necessity for Credit.—The Committee argue strongly that the abolition of the power to imprison for debt would deprive the working classes of the credit now given them by tradesmen. They point out that Parliament has "distinctly recognised the necessity for credit," and they cite the opinion of "a very large majority of the County Court Judges," that "the abolition of the power of imprisonment for debt would tend to affect injuriously the credit now given to the working classes, a credit which in the time of strikes or depression of trade is most beneficial to those who are thrown out of work." But it is to be noted that some of the Judges are opposed to the policy of the Act on the grounds (1) that the Judges have too wide a discretion in exercising the power vested in them by the Act; (2) that the evidence upon which the Judges act is very untrustworthy; and (3) that it is very mischievous in the effect which it produces, as tending to foster a very unhealthy system of credit. It will no doubt be said by the strenuous opponents of imprisonment for debt that the Committee has attached excessive importance to the value of credit in obtaining goods, and that it is much better for the workman to wait for things he wants, other than food and clothes, until he can pay for them. The Committee would seem to be much of this opinion, seeing that they recommend that there shall be no imprisonment for debt except in cases where the judgment debt has been obtained for either necessaries or for damages for torts.

Compulsory Pilotage.—Referring to the law of compulsory pilotage, the Royal Commission on the Port of London reported that it is "so honeycombed with exceptions and exceptions to exceptions that the whole law is in a chaotic condition, and is a fruitful source of litigation and trouble." At least one of the Commissioners was in favour of abolishing compulsory pilotage, and there was much in the evidence tendered to the Commission on the point to support the recommendation. The Commission, however, were not, as a body, prepared to support such a drastic proposal, and contented themselves with recommending the transfer of the business of licensing London pilots to the London Port Authority. The Government have left all pilotage matters as they were, but they have now appointed a Board of Trade Committee to inquire and report as to pilotage in the United Kingdom. Pilotage is compulsory in 64 of the 110 districts of the United Kingdom (of which two-thirds are the Trinity House districts), and there is no power in any pilotage authority or the Board of Trade to increase the area of compulsory pilotage, though there is to diminish it. It may be taken that the Board of Trade Committee now sitting will recommend that simplification of the pilotage laws so long asked for by the commercial community.

The Premier Brewery.—The history of Arthur Guinness and Son, Limited, and of the firm that preceded it, is interesting in many ways, and is recalled by the dividend recently declared. The business represents the largest brewery in the world, its immense profits are earned without the help of the tied-house system, and it is Irish. Since the formation of the company, now some twenty-three years ago, there has been almost an unbroken increase in profits. For the year ending June 30th, 1888, the first complete year of the company's existence, the net trading profit was £791,000, and the dividend on the Ordinary stock was 15 per cent., at which it remained for the next six years. For 1895, the dividend was raised to 16 per cent., and from that figure it advanced until for the year ending June 30th, 1908, it was 27 per cent., the net trading profit for that period being £1,209,000. It appears from the accounts that for the past twelve months the results were not quite so good as before, but the dividend was 14 per cent. This seems a heavy falling off from 27, but is not so in reality. A year ago the Board decided to capitalise £2,500,000 of reserves, by which the ordinary capital was raised from £2,500,000 to £5,000,000, the new security being issued to the stockholders as a bonus. The amount of stock held by each proprietor being doubled, the dividend, supposing a maintenance of the earning power, was necessarily halved, so that the 14 per cent. of the present year represents the high-water mark of dividends, being equal to 28 per cent. on the capital as it stood last year. At the present price of 390, the yield to the purchaser is 3¾ per cent.

Cotton Mill Accidents.—Several statistical tables have just been issued by the Accidents Committee of the Master Cotton Spinners' Federation relating to accidents in cotton mills during the twenty months ended February 27 last. The membership of the Federation represents 39,530,502 spindles, and the accidents reported were 19,075. Of those who suffered them 51 per cent. remained at work, 49 per cent. left work, 7 per cent. returned within seven days, 42 per cent. were away from work more than fourteen days, and 3 per cent. over seven days and under fourteen. Out of the total accidents, 10,378 occurred in the mule room; next come 2,749 frames in card room, 1,590 card engines, 797 ring spinning, 569 weaving, 388 winding and ruling, 276 warehouse, 207 cotton room, 259 blowing room. The number of accidents to males was 14,147, to females 4,925. A table of the returns shows the ages of the injured persons. Males stand thus:—12 years, 2·38 per cent.; 14 years, 8·29 per cent.; 20 years, 3·15 per cent.; 25 years, 3·60 per cent.; 30 years, 1·84 per cent.; 40 years, 1·46 per cent.; 45 years, 1·54 per cent.; 50 years, 1 per cent.; 60 years, ·24 per cent. With the females the percentage at 14 years was 10·07; 15 years,

8·05; 16, 8·27; 17, 8·73; 20, 4·03; 30, 1·80; and 40, ·90 per cent. In both cases it will be observed that the younger the age of the worker the more accidents are reported, 14 years heading the list. A settlement has been come to with the Home Office respecting fencing carding engines.

Sale of Sailing Ships.—A large number of British sailing ships have been sold recently, mostly to Norwegian and Italian owners. The feature of the sales has been the low prices that have been accepted. *Fair Play* gives some instances. A vessel of 1,499 tons register, built in 1885, which changed hands in August, 1906, for £4,400, has recently been sold for £2,800. A steel barque of 1,352 tons register, built in 1890, was sold in April of last year for £3 6s. 7d. per ton register, whereas in June this year a steel barque of 1,346 tons register, but built in 1895, was sold for only £2 9s. per ton. A steel barque of 1,519 tons register, built in 1893, fetched £3 4s. 6d. in June last year, but last month all that could be obtained for a similar vessel was £2 9s. 8d. per ton. In July last year an iron ship of 1,742 tons register, built in 1885, realised £2 7s. per ton. Last month a German iron barque, 2,250 tons register, which was sold in July, 1907, for £7,500, or at the rate of £3 7s. 8d. per ton, only fetched £3,350, or £1 9s. 9d. per ton. These figures demonstrate the heavy depreciation which has taken place in the value of sailing ships recently, due, of course, to the great difficulty of making them pay with the freight market in its present condition.

QUESTIONS AND ANSWERS.

Readers in search of information which cannot be obtained from the usual sources are invited to make their wants known in the *Journal*, in the hope that they may be assisted in their difficulties by their fellow members.

On all communications must be written the name and address of the sender, not necessarily for publication, but as a guarantee of good faith.

Each question or reply should be written on a separate sheet of paper, and should bear such signature of the writer, and such address as he wishes to appear.

Questions which can be answered from the usual books of reference, will not be printed.

ANSWERS.

COPRA (see pp. 756 and 773).—"Malay" will be interested to hear that M. Dybowski, Director of the Paris Colonial Gardens, has been conducting experiments in the preservation of copra from mould by means of sulphurous acid. Some samples so treated in 1905 still show no signs of deterioration. In June last he made a further trial on a consignment of 3,000 coconuts imported from the Malay Archipelago. The nuts, after being cut in two, were exposed to the action of the sulphurous gases by means of the Marot apparatus. The operation has been repeated on successive batches, and it now seems to be proved that under the sterilising influence of this gas the original condition of the copra is maintained.—H. M.

THE CACAO BEETLE, *Steirastoma Depressum* (see p. 565).—The cacao beetle is a very serious enemy to cacao, sometimes causing the death of the trees. It is quite generally distributed through the West Indies and Northern South America where it is usually known as a pest when cacao is cultivated on a large scale. The egg is laid in or on the bark of the cacao tree. The larva or grub of the cacao beetle when full-grown is about 1½ inch in length and ⅜ inch in width at its largest part. It is whitish in colour. The head is dark-brown, small, and equipped with powerful jaws or mandibles with which it tunnels its way through the wood.* The segments of the body are prominent, giving the larva a wrinkled appearance. There are no legs or feet, but on the dorsal and on the ventral surface of each segment there is a small area, slightly roughened, which, being pressed against the sides of the tunnel, enables the larva to work its way along. The pupa is formed in the tunnel made by the larva. The adult is a black and grey beetle, about ⅝ to ⅞ inch in length, and $\frac{5}{16}$ to ⅜ inch in width.† The antennæ are longer than the body, the segments swollen at the apical ends, the basal segment quite stout, the others slender. The head is broad; the thorax broad, flat above, with short stout projections on each side. The wing covers are strongly ribbed longitudinally and each is tipped with a short spine. The legs are long, the femora much swollen the tibiæ slender, the dorsal joints broad, flattened, and fringed with fine hairs. The ground colour is black, the gray being due to fine whitish scales, which are easily abraded; a fresh specimen, consequently, is much higher in colour than one that has been rubbed.

Life History.—According to Mr. Henry A. Ballou, B.Sc., Entomologist on the staff of the Imperial Department for the West Indies, no observations seem to have been made as to the length of time spent in the egg, larval, and pupal stages, nor as to the season of egg-laying, and greatest abundance of adults. The damage done to cacao trees by the cacao beetle is two-fold: (1) by the adult beetle, and (2) by the larva or grub. The adult beetle feeds to a considerable extent on the tender bark of young

* In my experience the larva never tunnels in the wood, but only in the thick fibrous bark of the cacao tree.—W. M. M.-S.

† These dimensions are rather under the average. The measurements of a large cacao beetle are 1¼ inch length and ⅜ inch width.—W. M. M.-S.

plants and young twigs and branches of bearing trees. This alone amounts to considerable damage, especially in a young plantation. But not content with that, the beetle deposits its eggs in any tiny crack or crevice in the bark of the tree, a favourite spot being the junction of two branches or where a branch joins the main stem. The egg hatches, and the larva burrows into the bark, where it feeds and grows and developes. It feeds on the fibrous portions of the bark down to the cambium layer, burrowing a tunnel in the bark below the outer corky layer. The tunnel may be made in any direction. It may be worked around in a complete circle enclosing a small space of two or three inches diameter; in a line parallel with the stem of the tree or the branch; but the greatest damage is done when the tunnel is made completely around the stem or branch. The direct damage by the larva results in the weakening of the tree, caused by the sap-flow being cut off; or in the death of the branch, or the whole tree. The effect on the young plants and young branches of bearing trees by the nibbling of the tender bark by the adult beetle, is considerable; and in a short time they present a very scraggy appearance. An indirect result from the attacks of the cacao beetle, is the liability of the trees to fungus disease from the spores entering the wounds made by the adult beetle, and the larva.

Remedial Measures.—(1.) Careful inspection of the trees and destruction of the larvæ. For a few days after the larva begins to tunnel in the bark of the tree there is no outward indication of its presence. The first sign is a gummy oozing from the entrance to the tunnel, which is very small. After several days, as the tunnel increases in length, the portion left behind by the larva begins to decay and fall in, and the presence of the larva is then plainly indicated. A small pocket-knife is the most convenient tool for cutting out larvæ. The tunnel must be carefully followed up and cleaned out, and the larva killed. The sides of the tunnel must be pared smooth, and an antiseptic dressing of resin oil, or coal tar and resin oil mixed in the proportion of one to four, applied to it. The method of wire-probing, recommended some years ago, is not of much practical use; for the direction of the tunnel is not apparent, and one never knows in what part of the stem or branch the larva is located, until the tunnel is followed up by cleaning out. (2) Catching the adult beetle by hand. During the day, the beetles may be seen resting on stem and branches, where they may be picked off by hand, or knocked off to the ground with a light thin bamboo rod, and caught. They may be caught in the same way on their favourite feeding places other than the cacao trees. They may be found on the heaps of freshly-picked ripe pods, on heaps of broken pod shells, on fresh prunings of branches lying on the ground, and on the stems of the *Pachira aquatica*, a tree that is much used for shelter belts in Grenada. The boys who are sent out to catch the adult beetles do not take only those that are in the open, as described above, but employ a method of dislodging the beetles from the topmost branches and from among the foliage where the majority of the beetles are resting, hidden from sight. A sharp, short vibration of the tree, caused by stamping with the foot against the stem, causes the beetles either to drop to the ground or fly to another tree, when they are seen, followed, and captured. (3) Cacao beetles do not like dark, damp places, so that it is wise to prune so as to obtain an even canopy of shade over the stems and main branches of the trees. All open spaces in a cacao field should be planted closely with tall-growing catch crops such as bananas. The borders of a field are generally more infested with beetles than the middle portions. Cacao beetles are fond of a sunny westerly slope, and it is from these places that it is most difficult to get rid of them. They are generally more in evidence during the dry months of the year. On one estate which the writer controls, containing about 200 acres of cacao, as many as 120,000 beetles, larvæ and pupæ, are destroyed every year, and this at a cost of about £50. On a neighbouring estate as many as 200,000 are destroyed annually. It is difficult to estimate correctly the loss to an estate through the ravages of this pest for the reason that it is seldom that a cacao tree is killed outright or even in a short period by beetle attacks. Generally a branch dies off here and there and the trees, if well cared for, will recover in a short time. When the attack is persistent, the trees gradually get into a poor condition and may eventually die.—W. M. MALINS-SMITH.

Diamond Estate, S. Mark's,
Grenada, B.W.I.

OBITUARY.

ARTHUR LEE, J.P.—Mr. Arthur Lee, J.P., of Bristol and Hayes, died suddenly on the 31st ult., at his residence, 37, Woodville-gardens, Ealing, at the age of 57. Mr. Lee was head of the well-known firm of Messrs. Arthur Lee and Brothers, Limited. He served for some years on the Bristol Chamber of Commerce, and was elected President in 1901, the year in which the Royal Edward Dock was opened. He was largely instrumental in forming the Port Extension Committee, which was established in 1899, and out of which grew the Port Extension League. He was also for four years a member of the Bristol Town Council.

Mr. Lee joined the Society of Arts in 1899, and in December, 1904, he read a paper on "The British Canals Problem," for which he received a silver medal. He also occasionally took part in discussions at the Ordinary Meetings of the Society.

Journal of the Royal Society of Arts.

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FRIDAY, AUGUST 20, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

H.I.M. THE EMPEROR OF RUSSIA.

At the invitation of H.R.H. The President, H.I.M. The Emperor of Russia has been pleased to accept election by the Council as an Honorary Royal Member of the Society.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

MODERN METHODS OF ARTIFICIAL ILLUMINATION.

By Leon Gaster, A.M.I.E.E.
(Editor of the *Illuminating Engineer.*)

PART III.*

High-pressure Gas-lighting.

I now come to one method of improving the efficiency of incandescent gas lighting, which, perhaps more than any other, has led to immense developments in recent years, namely, the use of high-pressure gas. There is no inherent advantage in using high-pressure gas except for the purpose of producing a more intimate mixture of gas and air coupled with a greater velocity of gas issuing from the burner, and therefore increased flame temperature with more perfect combustion.

Time will not allow me to enter into details as regards the many different systems of compressing the gas for subsequent use in this way, but I may make mention, among others, of the Scott-Snell, Sale-Onslow, Millenium, Grätzin, Pharos, and Keith and Blackman systems.

In the last-named system, of which I am privileged to show you quite the latest development to-night, a very compact type of compressor is used, which is driven by electricity, water, or from a belt, as may be desired.

Fig. 28.

Grätzin Inverted High-pressure Lamp.

The result of leading gas into the burner at a high pressure is a great gain in efficiency, and pressure as high as 55 inches of water is actually in use at the present day. For instance, the illumination of Kingsway and

* The Course consisted of four lectures, delivered on February 15th and 22nd, and March 1st and 8th. In re-arranging the material for publication in the *Journal*, the lecturer has preferred to divide it into six parts.

Aldwych, on the Millenium system, utilises a pressure of 54 inches, while the Sale-Onslow system at the new Victoria Station, uses 50. The new Keith inverted lamps just installed in Fleet-street are also run at a pressure of about 50 inches. It is true that the Salzenberg lamp, brought out in Germany, utilised a pressure of as much as one atmosphere, but it does not seem to have ever developed into a practical condition.

One point of interest in connection with the Keith apparatus, is a lubricating device, by means of which the compressor, once charged with oil, does not require a fresh supply for some considerable time. The compressor shown at this lecture is fitted with this automatic lubricating device.

The main point of advantage claimed for the inverted lamps, of course, is their high candle-power, as much as 73·6 candles having been obtained by some tests with ordinary town gas. However, only 60 candle-power per cubic foot is claimed by the makers. The lamps are made in all sizes from 60 candle-power to 1,500 candle-power, with single burners.

The high efficiency claimed is said to be obtained to a large extent by means of a pre-heating device, whereby the gas and air mixture is passed through a heater fixed on the bottom of the burner tube, as near the mantle as possible. It takes the form of two shallow cones, fixed base to base, with a diaphragm between, perforated at the outer edges. This has the effect of spreading out the mixture of gas and air over a large area of highly-heated surface before reaching the nozzle. The heating of the gas and air mixture takes place progressively, for as the mixture gradually moves forward it is brought into contact with surfaces which are more highly heated than those it has just left. At the same time, the heater has the effect of taking heat from the nozzle, and so prevents it becoming too highly heated at the tip.

An additional effect is obtained by heating the secondary air supply as highly as possible before coming in contact with the mantle. By this means as much of the waste heat as possible is utilized to give a regenerating effect.

To overcome the resistance of the burner, due to the large expansion of the heated mixture, and the high velocity at which it is necessary for the mixture to issue from the nozzle, a 4 in. Mercury Column Gas Pressure is required.

The larger lamps, if desired, can be arranged with "Automatic Distance Lighters," which enable them to be lighted and extinguished by the increase or decrease of the pressure occasioned by the starting or stopping of the compressors, or any other method of controlling the pressure at the lamp.

Fig. 29.

Keith Inverted 1,500 C[illegible] High-pressure L[illegible]

The largest lamp which [illegible] at this lecture is fitted with this [illegible]istance lighter device.

The advantages of hig[illegible]ighting where high candle-power [illegible]red are very obvious, though the[illegible] few inconveniences attached to the [illegible]

No doubt experience is teaching us to reduce the percentage of mantles broken in this way. Some particulars of the breakage of mantles and globes occurring when lamps are switched on suddenly, and the methods by

which these troubles were avoided in the case of high-pressure inverted mantles used in Berlin, have recently been given by Drehschmidt. (*Illuminating Engineer*, Vol. I., 1908, [illegible]51; *Journal of Gas Lighting*, Aug[illegible], 1908.) Mantles, however, are as a[illegible] specially strongly woven or even doub[illegible] order to resist high-pressure.

One point of some importance in the design, of high-pressure incandescent gas lamps, has been the adoption of lanterns containing two or three distinct mantles, giving in all, the same candle-power which a single big mantle would do. This method has several advantages. For one thing, a small mantle is in general not so liable to injury, and lasts longer

Fig. 30.

Illumination of Fleet-street by Keith High-pressure Gas Lamps.

than a large one; it may, in addition, be more efficient. Again, when three mantles are used, the breakage of one of them is not so serious, as there are two healthy mantles left burning. When there is but one mantle in the lamp, on the other hand, an accident to it puts the light out altogether. Yet another merit of the three-mantle arrangement is that it is possible, at a certain hour at night, to arrange for the extinguishing of two out of the three, thus effecting a saving without plunging the streets into complete darkness. This method of partly extinguishing the lamps is now used in Berlin, and other towns in Germany.

The Relative Merits of Pressure-Gas and Pressure-Air.—A considerable amount of discussion has recently taken place round the question of the relative merits of using compressed air or compressed gas in the burner; both, as we have seen, are capable of leading to the intimate mixture of gas and air which we desire to produce. Klatte, of the Pharos Company, has strongly recommended the use of high pressure air, urging several advantages. (*Illuminating Engineer*, Vol. I., 1908, p. 956, and references.) For instance, the original gas pipes can be used, and in the event of anything going wrong with the high-pressure air system, the light is diminished only and not extinguished.

When we use high-pressure gas, on the other hand, an accident to the compressor may have serious consequences, and the tendency to leakage is, of course, greater than with low-pressure gas. In addition, it is urged that the necessity for employing special meters for high-pressure gas, and other inconveniences in supplying the system to private consumers, is avoided by the use of high-pressure air. On the other hand, high-pressure air systems require two pipes, an arrangement which is not always convenient. It is interesting to recall that the method was adopted many years ago by the United Kingdom Lighting Trust in this country, and is still in use at the present day.

Another system to which reference may be mede is the Selas, in which a mixture of gas and air is compressed and supplied to the burner The system involves the mixing of gas with air, and therefore essentially differs from ordinary high-pressure systems. The gas, coming through the meter, passes into a mixing apparatus, in which it is automatically mixed with air in the proportion of two parts of gas to three parts of air, and this mixture then passes into a compressor, from which it is delivered into the service-pipes at a pressure of 10 inch water-gauge. The chief advantage claimed by the Selas system is its great economy and the variety of burners. The upright burners range from 25 up to 5,000 candle-power, the efficiency being 50 candle-power per cubic foot per hour. This efficiency is claimed to be realised even with the smallest burner. The pressure being only 10 inch water, any ordinary pipes may be used, and the leakage, if there be any, cannot be greater with Selas at 10 inches than with ordinary gas at 2½ inch pressure.

Self-contained Highly Efficient Lamps.

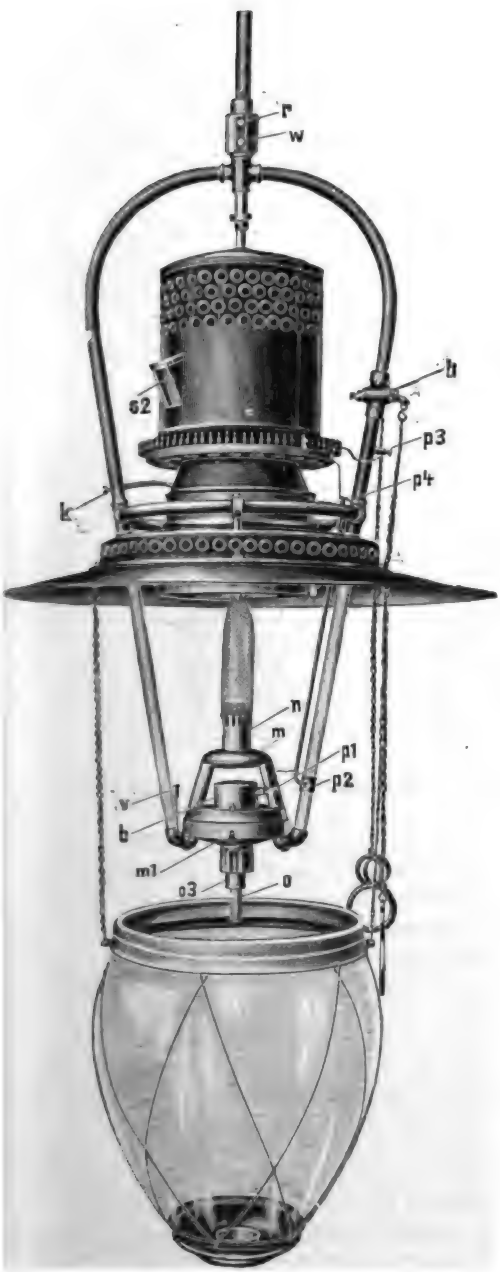
In any case, whether we use high-pressure air or high-pressure gas, it is usually necessary to make some alteration or addition to the system of mains. Attempts have therefore been made to introduce into ordinary gas lamps local pressure raising or regenerative devices. Thus Scott-Snell many years ago devised means of pre-heating the air supplied to the burner and securing a forced draught. Lucas sought to produce an increased draught by the use of special long chimneys, but this simple device rendered the lamp inconveniently long. More recently, the same lamp has been modified by the ingenious application of a thermopile, the junction of which is placed near the flame and supplies current to a small electrically-driven fan at the base of the lamp; while another improvement consists in a device to enable the junction of the pile to get heated without being actually in the hot zone of the flame. It is stated that the thermopile will last 1,000 hours before it requires renewal.

It will naturally be recognised that the heat-resisting properties of the metals used in the thermopile are the chief consideration, and therefore metals like copper, nickel, and aluminium are selected, and the life is considerably prolonged. The current required is but small.

As a result of the air sucked in by the electric fan at the base of the burner, a flame of very high temperature and a correspondingly high efficiency is obtained. At the same time the cool air drawn in by the fan keeps the base of the burner and the actual working parts cool, and promotes their wearing power.

For this lamp it is claimed that a minimum candle-power of 1,200, obtained at the consumption of only 30 cubic feet of gas per hour, is arrived at. It is also pointed out that the

FIG. 31.



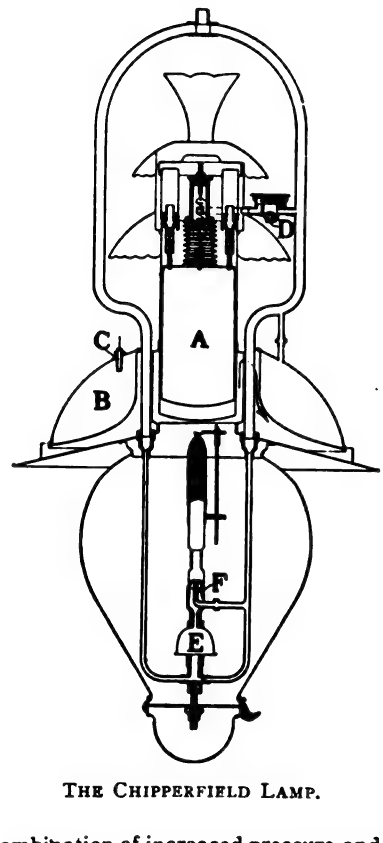
DETAILS OF LUCAS THERMOPILE LAMP.

[The gas enters through the regulator at *r*, passes through the cock *h* into the mixing chamber *m*, and finally through the burner at *n*, and so, after heating the mantle, up the chimney. In this is fixed the thermopile *t*, the current generated in which is carried by the wires p_1, p_2, p_3, p_4, to *m*, a small electro-motor, rotating about a vertical axis at a speed of 2,000 revolutions a minute. This motor is coupled directly on to a small fan, which creates the required draught.]

lamp is of comparatively small size, absolutely self-contained, and can be used with any pressure and quality of gas off the ordinary supply pipe.

Yet another type of portable high-pressure lamp is the Chipperfield, which utilises what is equivalent to a small hot-air engine placed above the burner; this automatically pumps air under pressure into the heated reservoir,

FIG. 32.



THE CHIPPERFIELD LAMP.

the combination of increased pressure and pre-heating resulting in a considerable increase in efficiency.

In the top of this lamp there is a movement worked by the waste heat of the burner which causes the air to expand in the cylinder, A, thereby forcing the displacer to rise.

Attached to this displacer are two valves which, when the air displacer is at the highest point, exhaust the expanded air, and when the displacer is at its lowest point draw in cool air. Attached to this displacer there is also a metal concertina which, when on the down stroke, draws in air through an inlet and outlet valve at D, and on the displacer rising the concertina compresses the said air, and passes it back

through the above-mentioned valves to a reservoir, B, which takes all the fluctuation out of the light.

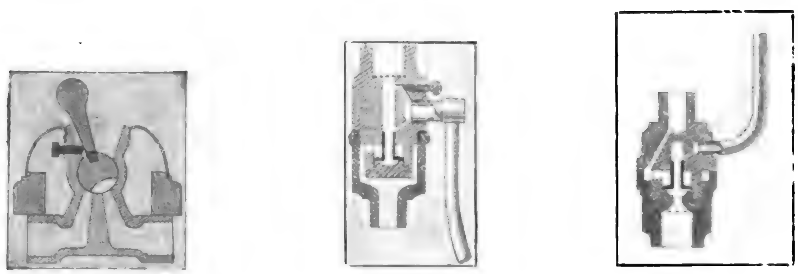
The reservoir is fitted with a blow-off valve, C, adjusted to a pre-determined pressure of 32 inches. The lamp is fitted with an air and gas nipple of special design, F, which enables the gas to be regulated by a turn of the cap. The air is regulated by a sleeve on the Bunsen tube. The movement can be replaced in less than five minutes by simply disconnecting one union.

[Since the exhibition of this lamp, fitted with the upright mantle, at the lecture, I have been given to understand that the firm are bringing out an inverted type from which good results have been obtained.]

Wolf gas is yet a third system of a kindred nature (*Illuminating Engineer*, Vol. I, 1908, page 681); it consists principally of such hydro-carbons as ethylene and ethane, and is claimed to be influenced to an exceptionally small extent by external temperature.

These liquid gaseous illuminants claim exceptionally high calorific value, oil gas being stated by Mr. F. D. Marshall to yield 8,000 to 10,000 units, and Blau gas over 13,000. This may account for the extremely high illuminating efficiency claimed, for it is stated that the equivalent of over 100 candle-power per cubic foot per hour has been obtained by using Blau gas.

FIG. 33.



DETAILS OF THE NORWICH DISTANCE-LIGHTING SYSTEM. (G. HANDS AND CO.)

LIQUID GAS SYSTEMS.

I may next say a few words about a system of gas lighting which has recently come into prominence, namely, the use of liquid gas of various kinds. To this I may refer again in my next lecture. Compressed gas of this description is mainly employed in cases in which portability is extremely desirable—for lighting railway carriages, &c. The coming of the inverted mantle and the possibility of making mantles which would withstand the vibrations of trains has led to considerable development of this method.

One of the older systems in this country is the Pintsch oil gas system, in which oil gas is subjected to a pressure of about 6 to 7 atmospheres per square inch.

The Blau gas again is a special liquid illuminating gas produced by the distillation of mineral oils, such as crude petroleum; the gas is in this case compressed at the exceptionally high pressure of 100 atmospheres, 20,000 litres being reduced to the bulk of 50.

AUTOMATIC IGNITION AND EXTINCTION.

I now come to one development in gas lighting which will be recognised to be of exceptional importance at the present day, namely, automatic ignition. If there is one respect in which electricity has claimed to possess a great advantage over gas lighting, it has been the ease with which electric lamps are lighted or extinguished. Naturally, therefore, efforts have been made to extend the same facilities to gas lighting.

One of the simplest systems of this kind has been the arrangement, employed in the Norwich system of gas lighting, of which I am enabled, through the kindness of Messrs. G. Hands and Co., to show you an example to-night.

In this system no air tubes or electrical wires are required. The switch itself, being in the form of a bye-pass cock, is inserted in the supply pipe to the fitting which it is required to control, and an automatic valve is applied to the nose-piece of the fitting, for the purpose of directing to its proper course the small quantity of gas which is required for a pilot light.

Thus the actual gas pressure supplied controls the valve in the nose-piece of the fitting, and turning on the full pressure is sufficient to enable the lamp to light up. The manipulation of the lamp inserted in the pipe provides either a bye-pass or allows the gas to flow freely to the burner. The system claims to be a very permanent one, only requiring trifling attention. In this case the resemblance to the ordinary tumbler electric switch is strikingly carried out.

Pneumatic and electrical methods of ignition recently formed the subject of a valuable paper by Mr. T. J. Litle, at the Second Annual Convention of the Illuminating Engineering Society of the United States (the *Illuminating Engineer*, Lond. Vol. I., 1908, p. 1025). The pneumatic system, he said, was not usually supplied to the ignition at distances of more than twenty yards, which is, of course, amply sufficient for an ordinary household, though special pressure-raising devices may be used to act on a lamp in a very large hall. Of course, the pneumatic systems pre-suppose the use of a pilot flame. In passing I may refer to a method of utilising a single pilot flame for the cluster of several mantles in the same lamp.

Another method which has been the subject of a considerable amount of experiment is electrical ignition. According to the usual system the kindling is accomplished by a jump-spark from an induction coil or magneto-generator. At the discussion of the paper by Mr. Litle just referred to, many divergent expressions of opinion were to be noted, some professing to have found the system completely satisfactory, while others found it very irregular.

It need hardly be pointed out that this is one of those cases in which the gas engineer has found it to his advantage to study the kindred subject of electricity. In the discussion of Mr. Litle's paper it was very generally agreed that previous failures had been largely due to deficient insulation. Failures may also be due to a spark occurring in the wrong position in the burner, and, therefore, failing to ignite the gas.

I am pleased to say that, by the courtesy of Mr. George Keith, I am able to show you the automatic electrical ignition used with the newest Keith lamps, which is, I believe, exhibited here in public for the first time. This latest form of controlling and ignition can be performed electrically, and possesses several novel features, one of the advantages being that it dispenses altogether with the use of bye-passes.

The arrangement on the lamp consists of a tubular body which is part of the down-stem, containing a permanent magnet fitted with a brass valve at the bottom, which drops into a seat and holds it tight by its own weight against gas getting into the burner. Above this permanent magnet is fixed the core of an electro-magnet, the coil of which is fixed on the outside tube. Conducting wires from one pole of the necessary battery fixed in a convenient spot are taken to each lamp, the return current passing through the gas-piping itself. The permanent magnet is therefore lifted or repelled by the passing of the current in certain directions, accordingly as the gas is required to be on or off in the lamp, and at the same time the same current passing through the platinum filament contained in a small chamber fixed on the burner nozzle ignites the gas.

It is hardly needful to point out that any automatic system for lighting interiors must be absolutely reliable. A very wide field, however, has been opened out in the automatic control of public lighting in the street.

Street lighting forms an essential part in the revenue of gas works, and therefore it demands a great share of consideration, not only on account of this revenue, but also because of the safety of public thoroughfares. This is particularly the case on account of the improvements made in electric lamps and the consequent increased competition of electric light.

With electric illumination all, or nearly all, lamps are operated from a central point. This arrangement makes it possible, if desired, to deviate at any time from the fixed lighting schedules or arrangements entered into with lighting authorities, making street lighting independent, and applicable to existing circumstances, due to meteorological and local requirements. These conditions will have to be transferred to gas, if gas wishes to maintain permanently its acquired position as a popular illuminant in competition with its rival, electricity. Various forms of apparatus and devices were resorted to a few years ago for the purpose of lighting and extinguishing street lamps. They utilised either electricity, gas pressure, or clockwork. Street lamp lighting by electricity has not yet found favour, on account of the great expense connected therewith, whereas the employment of gas pressure for operating distance-lighting has proved itself very reliable and free from objections.

A few years ago, the first experiments were made to use additional gas pressure for operating distance-lighters.

Experiments in the construction of pressure distance-lighters to operate by pressure waves led to the result of constructing two main kinds, one with a diaphragm, and one with a float or cup, on which the wave can exert its force. Some particulars of the use of the Alder and Mackay system in Tipton have been given by Stephenson (*Journal of Gas Lighting*, March 10th, 1908), who found that a very great saving in labour and in breakages of mantles, rods, and glasses was achieved by the introduction of the system.

In this case an increase of pressure of 1 in. to 1½ in. was maintained for about half a minute to a minute and a-half, and the wave seemed to travel practically instantaneously. An interesting result of this pressure-raising method is that at a certain hour of night, when the public lamps are extinguished, the lights of private consumers are also temporarily affected. It is stated that no objections were raised on this score; indeed the consumers rather welcomed this gratuitous information that midnight was at hand.

A very interesting automatic lighting and extinguishing apparatus for street lamps, is that of Dr. Rostin, which is employed very extensively in this country. In this case, the automatic arrangement consists of two valves which float in a special non-freezing and non-evaporating mixture of glycerine and water. A certain definite increase in pressure beyond the point to which the inlet valve is adjusted, has the effect of admitting the gas to the working bell, which turns on a main cock. It will be noted, however, that if afterwards the pressure falls a small amount, as may quite likely happen when it is lowered after lighting time, a rise before midnight does not have the effect of lighting up when the lamps are not supposed to work.

It may be remarked that the valves in this case have no actual work to do, and no friction to overcome, and therefore work quite correctly, the actual pressure on the cock being accomplished by the gas let into a bell, and pressing on a suitable diaphragm.

Another modern type of automatic control, depending on a wave of pressure, is the Bamag system, which I am also privileged to show here to-night. In this case, the exact pressure at which it is desired that the apparatus should regulate, may be adjusted by setting the pointer on the dial, and the apparatus can be

Fig. 34.

The Rostin Automatic Distance Lighting and Extinguishing Apparatus.

controlled either by a rising or falling wave of pressure.

Clockwork systems controlling street lighting, by which the lamps are turned out and lighted at a pre-determined hour, have also been utilised very frequently. These methods have certain advantages, being, perhaps, more reliable than others depending on a wave of pressure.

On the other hand, they have the disadvantage of being too automatic; they turn on and off the light at a certain hour, but on an exceptional occasion, for instance, when a fog is on, they, of course, do not take account of the fact, whereas an instrument controlled from the station can be made to do exactly what is wanted. Such clockwork methods have, however, also found a field for advertising signs, which can be left burning on the premises without the shopkeeper or his assistant being actually there. (Figs. 36*a*, 36*b*.)

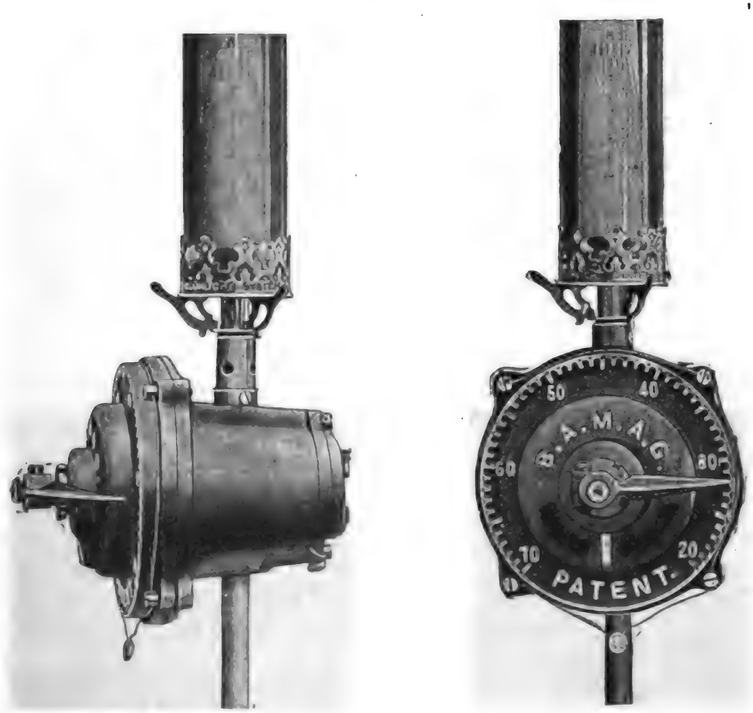
Perhaps, in passing, reference may be made to the discovery of Welsbach, that a mixture of finely divided iron and cerium in suitable proportions yields sparks when rubbed; it is anticipated that an automatic lighting device may be based on this principle, but the apparatus is not yet in a commercial stage.

[Since the delivery of this lecture a communication by Wunderlich has appeared, describing the practical application of a very similar process, *Journal für Gasbeleuchtung*, May 15.]

Before leaving this subject mention may be made of the various attempts that have been made to try to produce some apparatus which should be absolutely self-lighting. It has long been known, for instance, that spongy platinum, when exposed to a stream of gas, becomes heated, and may kindle the latter into a flame. Unfortunately, the heat of the flame tends soon to injure its quality. For this reason a device was adopted by means of which, as soon as the flame was lighted, the spongy lactive material was caused to fly out of the heating area. Even this, however, soon deteriorated, owing to the effect of atmospheric moisture, &c., and other causes.

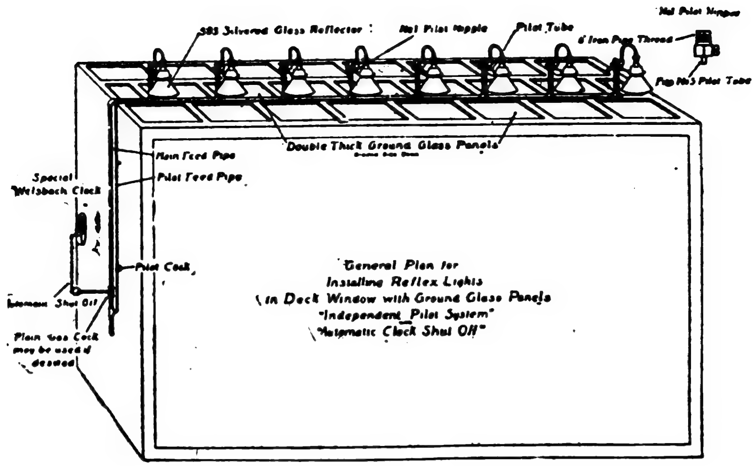
To-night I have on exhibition one of the newest types of self-lighting gas mantles of this kind, which is said to be exceedingly permanent if certain illuminatory precautions

FIG. 35.



"BAMAG" AUTOMATIC DISTANCE-LIGHTING AND EXTINGUISHING APPARATUS.

FIG. 36a.



METHOD OF LIGHTING SHOP WINDOWS BY GAS; LIGHTING CONTROLLED BY AUTOMATIC CLOCKWORK ARRANGEMENT.

FIG. 36b.

PHOTOGRAPH OF WINDOW ILLUMINATED BY SYSTEM SHOWN IN FIG. 36a.

in the use of the mantle are taken. I am informed, however, that some difficulty may be experienced in applying this device to very poor gas containing but few hydro-carbons. However, we can regard this only as an interesting attempt to solve the problem.

FIG. 37.

SELF-LIGHTING MANTLE. (J. MAYER.)

STREET LIGHTING.

It may, perhaps, be expected that I should say a few words about one use for gas lighting which is receiving considerable attention at the present time, namely, street lighting. I have already referred to the recent developments in the City of London, where the Keith high pressure inverted lamps have just been installed in Fleet-street. An interesting detail of this installation is the manner in which the lamps are attached to the house by means of brackets, instead of being suspended on lamp-posts.

An analogous method of avoiding the use of lamp-posts is, of course, the suspension of flame arc lamps above the roadway on wire cables in Cannon-street. This method is now very widely employed on the continent. It has several obvious advantages but is not so easily applicable to gas lamps, though, as will appear later, it has recently been used in Germany.

The competition between high-pressure gas and flame arcs for street lighting has been very keen both here and on the Continent. Many of you may know of the report issued by Mr. Voysey on the lighting of the City of London (*Illuminating Engineer*, Vol. I, 1908, p. 605). Whatever we may feel as regards Mr. Voysey's conclusions, I think it is of interest to observe that these results are fundamentally based on actual measurement of illumination in the streets.

In Berlin an interesting situation is presented by the fact that the gas generating station is owned by the city, while the electric lighting companies are private, but pay handsomely for their privileges, and are, therefore, a valuable source of income to the city. Recently the use of the Blondel flame arcs under the hands of Dr. Bloch has given rise to very good results, while Dr. Drehschmidt has recently described the developments in high pressure in inverted gas lighting which kept step with the development in electricity in this city.

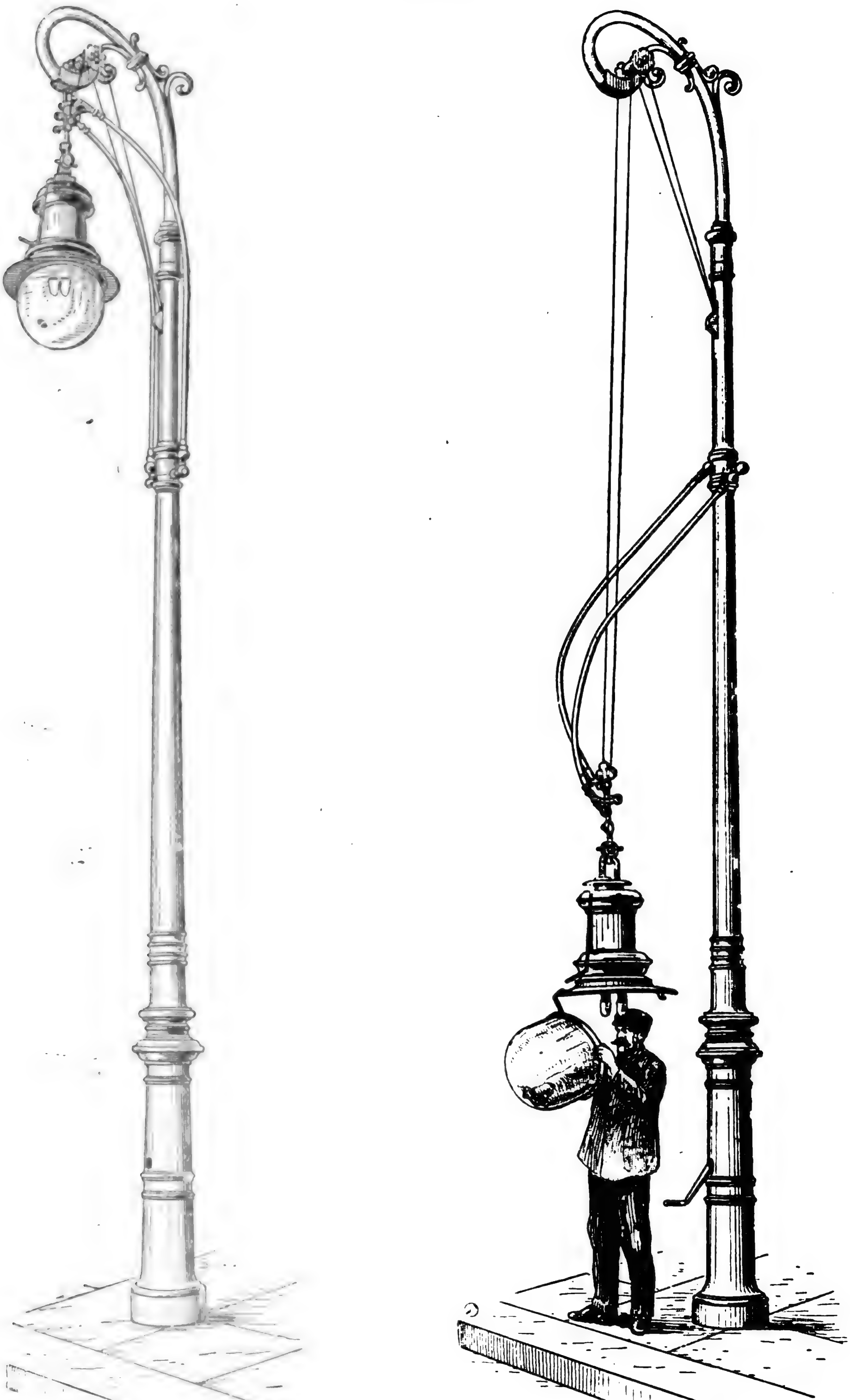
A very valuable precedent has recently been established by the authorities in the city of Boston, U.S.A., who dispatched experts connected with various systems of lighting to make a tour of the Continent and report on existing methods of street illumination, before taking any decision on the matter. It need hardly be pointed out how essential are the services of *experts* in order to prepare reliable data for the guidance of municipal authorities, and the city will doubtless reap the benefit of their foresight.

[Since the delivery of this lecture a deputation appointed by the Streets Committee of the Corporation of London has paid a visit to the Continent, with the object of examining the lighting of the chief cities in Europe, and has published its experiences. The method of street lighting preferred by the deputation consists of inverted high pressure incandescent gas lights, centrally placed in the street and equipped with raising and lowering apparatus; where this is not possible electric lighting is recommended.

The suggestion that high pressure incandescent gas lamps should be raised and lowered for attention in the same way as arc lamps is somewhat novel, and has given rise to some surprise; I have nevertheless recently seen and had an opportunity of inspecting a form of apparatus which is now being manufactured by Messrs. Ehrich and Grätz, in Berlin, and which is said to enable this to be satisfactorily accomplished.

I have also had an opportunity of observing

FIG. 38.



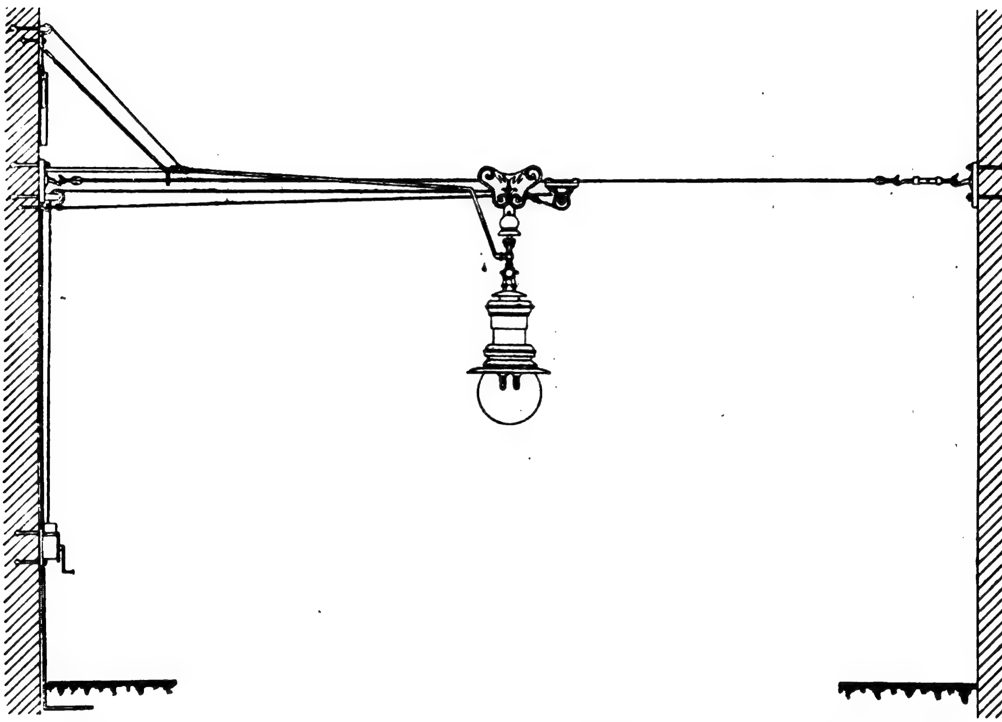
ARRANGEMENT ENABLING HIGH-PRESSURE GAS LAMPS TO BE LOWERED IN THE STREETS TO RECEIVE ATTENTION. (MESSRS. EHRICH AND GRÄTZ, BERLIN.)

this system in the experimental stage in the streets of Stuttgart, in Germany. I have, however, been informed by several Continental experts that the method is not yet so satisfactory in the case of high-pressure gaslighting as it has been found to be in the case of electric arc lamps. A considerable amount of experiment has been necessary in order to make the arrangement practicable, and to avoid possible leakage at the joints, deposits in the piping in winter, corrosion, &c. Formerly a flexible tube, enabling the lamp to be lowered, was used, but more recently it has been found preferable in Stuttgart to employ a jointed gas-pipe, and to arrange for the lamp being brought to the side of the street, before being lowered. In Stuttgart, both high-pressure gas and high-pressure air systems have been used, the latter, however, necessitating the use of two distinct pipes to convey the gas and air respectively.

In adopting a system of this kind, however, it must be borne in mind that the polar curve of light-distribution of flame arc lamps differs considerably from that of incandescent gas-lamps, and that the method and height of suspension that is found satisfactory for the one, may not be equally so in the case of the other. And, in addition, it may be suggested that when it is found desirable to instal high-pressure gas lamps fairly low down in the streets, they should be equipped with some form of diffusing globe; otherwise the effect is apt to be glaring. It may be mentioned that this deputation did not contain any experts connected with the various methods of lighting examined; therefore, while recognising the importance of the precedent established by municipal authorities studying for themselves systems of illumination, one must be cautious in advocating too sudden and extensive modifications in existing systems of lighting the streets of London, as a result of their experiences.

It need hardly be said, moreover, that it would be unwise to attempt the lighting of all varieties of streets on any uniform special plan such as that outlined above, and it is to

FIG. 39.



METHOD OF SUSPENDING HIGH-PRESSURE INCANDESCENT GAS LAMPS ABOVE ROADWAY

(The lamp is shown hung across the road in its normal position. When requiring attention, the jointed piping enables the lamp to be drawn aside to the pavement and lowered.)

Fig. 40.

View of Street in Stuttgart (Germany) Illuminated by Incandescent Gaslamps slung across the Roadway.

be noted that further experiments in the streets of London are to be conducted before any final decision is taken. The question is who ought to undertake these tests, so that we may accept the results as unbiassed ?]

A Calorific Standard.

Prof. Morris in a recent article suggested that entirely different results would naturally be obtained if the gas used was London gas, or the much richer gas employed in Edinburgh. This leads one to comment on what is now felt to be a rather curious anomaly in the present conditions of gas testing, that we still test gas in terms of its illuminating value, while, as a matter of fact, now that incandescent gas mantles are so widely used, it is the calorific value in which we are mainly interested.

The question has already arisen how far we shall continue to abide by the legislation of the past, or whether we shall not eventually entirely abandon the test of illuminating value, and be content with producing non-luminescent gas of a high calorific value producible at a distinctly cheaper rate.

This matter has been the subject of much discussion in this country, and very careful consideration in the United States, where a recent Committee of the American Gas Institute reported upon it at great length. I believe that in Chicago a calorific standard has already been set up.

In this country, legislation of recent years has made several concessions to this point of view. For instance, in 1900 the South Metropolitan Gas Company succeeded in promoting a Bill authorising them to reduce the illuminating value of their gas from 16 to 14 candles, and last year a notable step was undertaken by the Edinburgh and Leith Gas Commissioners in agreeing, in accordance with Mr. Herring's recommendation, to reduce the candle-power of the gas in that town from the high value of 20 to 14. The Gas Light and Coke Company have also now definitely recognised a calorific test in addition to tests of illuminating power.

Although this method of insisting only on an illuminating value of gas, when calorific value is all important, may seem rather strange, yet there are certain difficulties which will probably lead to only a gradual change in existing regulations. For instance, it is urged that one of the chief advantages of adhering to a standard of illuminating value is that any appreciable percentage of inert gas is immediately detected by the decrease in illuminating value.

Although an immense amount of work has been done on the subject of gas calorimetry in this country, it seems to be admitted that the process is far from being such a simple one as the illuminating test at present employed, and that until recently sufficiently accurate instruments for the purpose were not available. However, there are indications that a change will soon come.

In Germany, too, I was given to understand by Dr. Drehschmidt that calorific tests are regularly undertaken by the gas company in Berlin, and a systematic record of the qualities of the gas, in this respect, constantly kept, in order that any deterioration in heating value may be immediately recognised and detected.

I notice, however, that Herr Lebeis, in a paper recently read in Berlin, and reported in the *Journal für Gasbeleuchtung* (August 14), remarks upon the fact that in different districts both the pressure and the calorific value of the gas supplied are often found to differ very considerably; consequently a type of burner which is satisfactory in one locality may not be equally so in another. The same point is emphasised in a recently published address of Mr. H. O'Connor (*Gas World*, Aug. 14), who indeed goes so far as to assert that "a burner which was a good one in one town might be an absolute failure in another."

Lebeis describes an interesting modification of the incandescent burner which is intended to avoid this difficuly, and which he terms the "Aerostat." This consists essentially of an arrangement covering the inlet holes of the burner which contracts and expands with the heat, admitting more or less air, and automatically maintaining the most favourable conditions for combustion. In this it seems to resemble the thermostat described by Litle and Whitaker in the United States. (See p. 786). Besides allowing for differences in calorific value and pressure of the gas supplied, this arrangement is also intended to compensate for the alteration in the conditions which prevail when the burner has only just been lighted and is cool, and those which are present when it has reached its normal hot state. These new burners are made for small candle-powers, as low as 33 mean hemispherical candle-power.

[This matter of a calorific standard has just been commented upon in the annual address of the President of the Gas Institute, who foresees its ultimate adoption. A very interesting

paper by Mr. C. Forshaw, delivered on this occasion, illustrates most forcibly the fact that there are other factors, apart from calorific value, such as flame-temperature, shape, and volume, which affect the performance of an incandescent gaslight. Mr. Forshaw also demonstrates how the incandescent illuminating power of two gases, hydrogen and carbon monoxide, may be very different under apparently similar conditions, even though both have approximately the same calorific value. Mention may also be made in this connection of the exhaustive experiments of M. Sainte Claire Deville, who has recently published an article in *The Illuminating Engineer*, July, 1909, summarising his views on the subject.]

Relations between Company and Consumer.

In my first lecture I referred to the valuable work of the Boston Edison Electric Illuminating Company, in assisting the consumer and undertaking to advise him how to use his lights to the best advantage.

This attitude has also been adopted by gas companies in the United States, and, I am happy to observe, by the most enterprising companies in our own country as well. For instance, the Gas Light and Coke Company and other companies here fully realise the necessity of keeping the consumers thoroughly satisfied, and undertake for a small charge to maintain their gas burners and mantles in a satisfactory condition.

The educational value of such a provision is proved by the fact that consumers not infrequently eventually learn something of the adjustment of burners and mantles from the company's representative, and prefer to save money by undertaking the supervision themselves. On the other hand, it must be confessed, that they do not always realise the real economy of renewing mantles promptly as soon as the candle-power has begun to fail.

The Gas Light and Coke Company make a practice of renewing mantles when their initial candle-power has dropped 25 per cent. This usually occurs after about 200 hours burning. We have thus an interesting analogy to the "useful life" of glow lamps, which is usually assumed to be the time that elapses before their candle-power is reduced by 20 per cent. from their original value.

The Company still undertake the supervisio of some 200,000 burners, and it is probable that very many more customers will now look after their own installations who were originally educated by the Company to do so. It is also interesting to learn that the Company make a practice of thoroughly testing mantles supplied to customers, by a rigid specification involving both tests of life and candle-power, and showing resisting power against vibrations.

In my present lecture I think I have said sufficient to indicate the exceedingly wide scope and scientific nature of the problems with which the gas profession has now to deal, and the enterprising manner in which many of them have been met during the last few years. In conclusion, I would like to emphasise one point which follows as a natural consequence, namely, the necessity for making provision for the adequate education of the young men of the future.

During the last year a great figure in the gas industry, Sir George Livesey, has passed away, and I think some mention might be made on this occasion of the admirable decision of the Gas Institute, and those who attended a special meeting with the object of honouring his memory. It was decided to create a professorship of gas engineering in his memory at Leeds University; the necessary arrangements have now been made, and this professorship may be regarded as an accomplished fact.

I hope that this will lead to the prosecution of many researches of great value to the industry with which Sir George Livesey was so long associated, and that manufacturers will promote the welfare of the scheme by encouraging those who take advantage of these facilities.

DEW-PONDS.

The August number of the *Geographical Journal* contains an interesting paper by Mr. Edward A. Martin, F.G.S., on "Dew-ponds," the subject, it will be remembered, of a paper read before the Society last session, by Mr. George Hubbard, F.S.A., which led to a considerable amount of correspondence in these columns. While agreeing to a large extent with Mr. Hubbard as to the general principles on which these ponds are constructed, Mr. Martin differs from him as to the precise process by which they obtain that portion of their supplies which comes from fog and dew. According to Mr. Hubbard, dew cannot be received by a pond unless the temperature of its surface has fallen to the dew-point. Mr. Martin's view is stated in the following paragraph:—

"The effect of radiation of heat from a pond upon the air above it must be regarded, I think, in a different light to the effects of radiation of heat from

the earth's surface, *e.g.*, the down-land. In the latter case, the heat rises with vapour out of the interstices of the soil, and is dissipated into space. The soil being cooled, brings about the cooling of the stratum of air in contact with it. When the cooling reaches the dew-point, the best radiators receive a deposit of dew. But as regards radiation from the surface of the pond, we have seen that the surface temperature is such that it can seldom have effect in cooling the air above it, since the air is already at a lower temperature. The cooling of the air must have been due to other causes, and I doubt if equilibrium between the two is ever obtained. Take one of the cases mentioned. At 9.50 p.m. the water was, everywhere in the pool, at 61°. The air immediately above it was 56°. The water was, no doubt, losing heat, but the air was losing it more rapidly, and the temperature of the air would easily fall below dew-point some hours before that of the water did the same. In that case, the point of saturation being reached, the stratum of air must give out some of its moisture, and this would be rapidly assimilated into the pond. If evaporation of the pond were proceeding at the same time, this would tend to cause the point of saturation of the air to be reached the earlier. So I am inclined to think that dew may be received by a pond on its surface even while the pond-water itself has not yet fallen to dew-point. On the other hand, if it can only receive dew by chilling, as it is often said to do, the air above it, I cannot see how pond-water can ever reach a temperature at night time lower than in the air above it, which would be necessary, if there is anything in this alleged chilling, so long as there is no change in the weather. It could only happen after some hours of freest radiation, and by this time probably the early sun will have begun to warm the air, the effect of this being to increase the amount of vapour which the atmosphere could hold without being saturated, and hence removing all possibility of precipitation."

The point deserves to be further investigated, for it possesses not only a scientific interest, but, in view of the possibility suggested by Mr. Hubbard of employing dew-ponds to supply water in certain lands which at present are waterless, a very practical one also.

FORTHCOMING INTERNATIONAL EXHIBITIONS.

Some interesting information with reference to forthcoming international exhibitions in various parts of the world has recently been given by the representatives of the United States Government in the countries concerned. To commence with the exhibition to be held in Brussels in 1910, it is reported that more foreign participation has been secured than for any former Belgian exhibition. The exhibition grounds are situated on the south-eastern end of the Bois de la Cambre, a short distance from the centre of the city of Brussels. The grounds occupy nearly two hundred acres, and are directly reached by a new extension of the Avenue Louise. Space has been secured by Belgium, the United Kingdom, Germany, Italy, Netherlands, Canada, China, Denmark, Spain, Portugal, Guatemala, Turkey, Uruguay, and Persia. The last Belgian international exhibition, held at Liège, granted space to exhibitors amounting to over one million square feet. In Berlin an international exhibition will be held in 1911, beginning on March 18th and closing on May 15th. The exhibits will represent means of traffic and travel by land and sea, the equipment of conveyances and lodging places for the convenience of the travelling public. The authorities permit any city to install an exhibit demonstrating the methods of lodging, instructing, and entertaining foreign visitors. One of the aims of the exhibition management will be to attract the attention of foreigners to the various places of interest in Germany. The scope of the exhibition is indicated by the following divisions under which exhibits will be grouped:—(1) Railways, sleeping-cars, special trains, dining-cars, steamships, and equipments; (2) tourist agencies; (3) societies for the improvement of travel, tourist clubs; (4) summer resorts, baths, and places of recreation; (5) lodgings and maintenance; (6) guides and tourist literature; (7) industries connected with travel, including cars, boats, airships, bicycles, and saddlery; (8) travelling equipments, comprising utensils, luggage, travelling apparel, outfits, photographic, optical, and similar apparatus; (9) expeditions and discoveries; (10) cinematographic reproductions and lectures. In Norway, an exhibition will be held at Bergen from June 1st to September 15th, 1910. This exhibition will be devoted to tourist and domestic industry exhibits. Foreign firms who make a business of furnishing hotels, foreign steamship companies interested in Norway's tourist traffic, and firms dealing in sporting goods, may, under certain conditions, exhibit goods through local representatives. In Mexico there is to be a celebration in 1910 of the centenary of the country's independence. The people as a whole, are even now, it is said, taking an interest in the coming celebration. In Matamoros, for example, collecting boxes are placed in various public places for receiving voluntary contributions. One or two entertainments have also been given to raise money for the same purpose. As far as can be learnt, the actual celebration will take place on September 14th, 15th, and 16th, 1910. Some of the larger cities will probably have two or three weeks devoted to the "fiestas," but on this matter each town will probably make its own plans. In Panama, much interest is already being taken in the proposed world's fair to be held in the city of Panama in 1915. It is stated that a number of prominent men have consented to be honorary presidents and vice-presidents, and that several meetings have already been held. One of the wealthy landowners of the Republic has given a beautiful site of three hundred acres in the Sabanas.

WOOD-PRESERVING PROCESSES IN GERMANY AND FRANCE.

Various methods of applying preservatives to railroad ties and telegraph poles have been in practical use in Europe for more than twenty years. It would be difficult to find in any advanced European State a single railway, telegraph, or telephone line the ties and poles of which have not been impregnated with an antiseptic composition. Figures are published relating to twenty German telegraphic lines, the impregnated poles of which were set at various intervals from 1877 to 1893. Of those set in 1877 about 35 per cent. were still sound and in use after twenty-six years service, and of those set from 1891 to 1893 there are records of five lines upon which all the poles are still standing. The American Consul-General at Hamburg says that the Bavarian postal service, after thirty years' experience, certifies that the known average life of impregnated poles in Bavaria is seventeen years and a half, and the German Imperial Administration calculated, in 1903, that the known average life of such poles was about sixteen years. In the meantime the work of impregnation is being more perfectly performed, so that future statistics will show better results. In France, the Eastern Railway Company announced, in 1889, that in the twenty-four years preceding 67 per cent. of its untreated oak ties had been replaced, while only 16 per cent. of such as had been treated with creosote had been removed. Beech ties properly impregnated, according to the chief engineer of that railway, have an average life of thirty-five years. More recent conclusions reached in the same system were to the effect that 80 per cent. of creosoted beech ties were good after twenty-seven years of service, while only 54 per cent. of oak ties treated in exactly the same manner were good after twenty-four years of service. The results of impregnation appear so conclusive and undisputed that it would be futile, says the Consul, to present further details on the subject. In recent years the most useful preservative agents in use have been chloride of zinc, creosote, and bichloride of mercury, applied by imbibition, or by impregnation by injection forced by the pressure of the air. This second method of treatment generally consists in placing the wood in closed metallic recipients from which the air is pumped, and the liquid then introduced under high pressure. Until comparatively recently, it was very common to treat wood by injection under pressure of chloride of zinc, diluted with water. While this antiseptic is efficacious, it loses its qualities and becomes hygroscopic. To overcome these disadvantages, creosote was added to the mixture, and under the title of "mixed impregnation" this system has been adopted for the treatment of white wood ties which are too cheap to warrant the use of creosote alone. Hard wood ties, on the other hand, are impregnated with creosote alone, the general effect of which is to close the pores, coagulate the sap, and kill the micro-organisms in the wood. The use of creosote alone is quite unusual in the treatment of telegraph and telephone poles, because of the odour, tendency to melt and run under the sun, and objections raised by the men employed to deal with them. It is common therefore to use bichloride of mercury (the French Government use sulphate of copper), the efficacy of which has been known since the middle ages, when it was used to arrest decay and the action of insects. At the Himmelsbach plant, near Freiburg, this is used in 66 per cent. solution. The wood is plunged into timber or cement receptacles, and there remains from ten to fifteen days. In this plant, moreover, treated poles are given a special coating of some unknown antiseptic, which extends about two feet above, and two feet below the point where the pole enters the soil. This application protects the part where the variations in humidity commonly attack the pole. In the Himmelsbach establishment, there are tanks for impregnating forty ties at a time, under pressure; these tanks being about sixty-five feet long, and over six feet in diameter. Their baths for treating telegraph poles are ninety-eight feet in length.

HOME INDUSTRIES.

The Whisky Industry.—The final report of the Royal Commission on Whisky and other potable spirits does nothing to confirm the rather general opinion that most of the spirit sold in public-houses, and the cheaper priced bottles, is deleterious in its rawness, and adulterated. On the contrary the evidence before the Commission "failed to establish that any particular variety of whisky was specially deleterious." Statements were not uncommonly made that raw spirits, and the cheaper variety of spirits consumed, for instance, at fairs, were specially liable to be deleterious, and to cause "some of the more severe symptoms of intoxication," but this evidence generally amounted to little more than a mere statement. As to adulteration, the Commissioners "were unable to obtain evidence pointing to the presence of any known deleterious substances in excessive quantity in these spirits (whiskies which had been obtained by Excise officers at fairs and public-houses in low-class districts in England, Scotland, and Ireland), or that any foreign substances had been added to them." What "excessive quantity" means in this connection is a little obscure, but the general conclusion is plain and reassuring. It is the conclusion arrived at by the Select Committee of 1890-1, who in their report say, "Your Committee arranged with the Inland Revenue that about fifty samples of spirits should be collected from public-houses, shebeens, and fairs, in various parts of the country to ascertain whether adulterations of a pernicious character might be put into them by the retailer before being given out to the customers. It is pleasing to say that not a single case of such adulteration was found. They varied greatly in strength, being from 14 to 30 under proof, but the spirit was normal."

Absence of Adulteration.—The Commissioners were appointed to inquire whether in the general interest of the consumer, and in the interest of the public health, or otherwise, it is desirable to place restrictions in the materials or processes which may be used in the manufacture or preparation in the United Kingdom of whisky; to require declarations to be made as to the materials, processes of manufacture or preparation, or age of any such spirit; to require a minimum period during which such spirit shall be matured in bond; and to extend any requirements of the kind mentioned to any such spirit imported into the United Kingdom. To all these questions the answer of the Commission is in the negative. They find that there is little or nothing to be added to the Report of the Select Committee on British and Foreign Spirits appointed by the House of Commons in 1890, presided over by Sir Lyon Playfair, and quoted above. As to "What is whisky?" the report takes a middle course. It does not altogether agree with the purists that whisky is a very strictly defined thing—spirit produced in a pot still from either malted barley, as in the case of Scotch whisky, or from barley malted or unmalted, with certain additions of other cereals, as in the case of Irish whisky. The quantity of spirit made in Scotland or Ireland from malt alone, or from a mixed mash of unmalted grain, has been far in excess of the quantity made from any other description of materials, and in recent years practically no spirit has been distilled at any Scotch or Irish distilleries from any materials other than malt and grain. "The general conclusion," say the Commissioners, "therefore, on this part of our inquiry is that 'whisky' is a spirit obtained by distillation from a mash of cereal grains saccharified by the diastase of malt; that 'Scotch whisky' is whisky, as above defined, distilled in Scotland; and that 'Irish whisky' is whisky, as above defined, distilled in Ireland."

Shop Assistants.—The Shops Bill introduced by the Home Secretary last week will not be passed this Session, and is not likely to pass without substantial amendment. The Bill has been introduced, as the Home Secretary explained, with the object of promoting discussion in the country, "and to obtain, if possible, something like unanimous support for its principles." The evils the Bill is intended to grapple with are admitted, but in the attempt to remedy them on the lines of the present Bill it may be found that the "small man" would suffer grievously. The basis of the Bill is that a shop assistant shall not, save as provided by this Act, be employed about the business of a shop for more than sixty hours (exclusive of meal times) in any week. The limitation of hours would not affect the larger shops to any appreciable extent, but it would be otherwise with the small man. The hours of laundry workers, for instance, are very long, and more than cover the whole time during which shops would be open if the Bill becomes law. Now they go to the little shops, but those under the Bill would be closed as well as the large ones. While an assistant's working week might be limited to sixty hours, it would be difficult to debar a man who, perhaps with the assistance of his wife, is conducting a small business, from the opportunity of making a little more money by hard work. There would be difficulty too with those shops in which branch post offices are conducted. Under the Bill shops would for the purpose of the transaction of post office business be exempted from the provisions of the Act to such extent as the Postmaster-General might certify for the purpose. It will seem to many a little incongruous for the law to insist that the needs of the people in respect of the purchase of food can be met by shops closing early, while for the sale of postage-stamps shops have to remain open until later hours. It is sought to meet the difficulty as to the Jews by giving the Secretary of State power by order to declare any area specified in the order to be an area inhabited largely by Jews, and in any such area it shall not be obligatory to close a shop before two o'clock in the afternoon on Sunday if the shop is closed for serving customers from sunset on Friday to sunset on Saturday.

The Thames Steamboat Service. — Now that another attempt is being made to run a Thames steamboat service, it may be interesting to note the history of successive attempts to supply and maintain a Thames passenger service. The first venture of the kind was undertaken by the City Steamboat Company, which was registered in 1845. It commenced with eight boats, and paid an average dividend of 10 per cent. for thirty years, giving a bonus of one £10 share for every two shares held. In 1875 it was merged into the London Steamboat Company, and at the time of its disappearance as a separate organisation it possessed 17 steamers built out of profits. The London Steamboat Company amalgamated, in addition to the City Steamboat Company, the London, Westminster, and Vauxhall Steamboat Company the Sun Steamboat Company, the Westminster Steam Packet Company, and the Waterman's Steam Packet Company. It started with a capital of over £400,000, and its gross earnings for 1876-77-78 were £115,000, £117,000, and £118,000 respectively. Then came the disaster to the *Princess Alice*, and the steamboat service of the Thames has never recovered it. The Thames and Channel Passenger Company took over the business of the London Steamboat Company and undertook to pay 10 per cent. on its first and 7 per cent. on its second mortgage debentures, and to build a new vessel each year. It failed; the gross receipts for 1879 being only £72,000. The Thames and Channel Steamship Company was formed to take over its assets, but only lasted a few months. The River Thames Steamboat Company then took over the boats, ran them for two years, and went into liquidation. In 1888 the Victoria Steamboat Company was formed, to be soon followed by the River

Thames Steamboat Company, which was equally unsuccessful. The County Council's experiment has ust ended in the disposal of the last of its boats at a rubbish price, fourteen having been recently sold for £5,500.

A Ring-Spinners' Association.—As mentioned in these Notes some time ago, it is proposed to form a Ring-Spinners' Association for the purpose of keeping up prices, and the preliminary steps are now being taken. It is to be assumed that the promoters of the Association expect to be able to obtain a great majority of the ring-spinners for it would be difficult, if not impossible, to maintain prices with any large number of outside weak sellers. If the Association were unable to obtain their minimum prices they would have to make stock or stop machinery. Spinners will not stock at high prices. A meeting will be held on the 24th August to authorise the Provisional Committee to proceed with the formation of the Association, to submit proposals, and to elect a general committee. But how will minimum prices affect markets where Lancashire has to meet competitors untrammelled by such limitations? In this connection it may be noted that according to the New York "Journal of Commerce" there is "an enormous increase already provided for in the additions to cotton mill spindleage in New England and the South." It is said on the same authority that this year there will be the greatest increase in spindles in any year since the southern industry began, and that a further expansion in new mills is expected in 1910. "Ultimately," says the "Journal of Commerce," "it is expected that this increased spindleage will bring about a keen domestic competition, and will lower the prices of goods, more particularly the fine cottons that will be excluded from importation through the operation of the new law." And this on top of the abnormal expansion in cotton spindles and looms in Lancashire!

GENERAL NOTES.

Memorial Tablets. — The London County Council have affixed to the house on Hampstead-heath known as "North End-place," and previously as "Wildwoods," a tablet bearing the inscription: "William Pitt, Earl of Chatham, 1708-1788, Prime Minister, lived here." There seems but little doubt that this is the house where Pitt resided for some time in 1766 and 1767 when he suffered so terribly from suppressed gout as to be quite unable to attend to affairs of State. A pathetic picture of the great Prime Minister is given by Mr. Whately (Mr. Grenville's private secretary) in a letter dated 30th July, 1767: "Lord Chatham's state of health . . . . is certainly the lowest dejection and debility that mind or body can be in. He sits all day leaning on his hands, which he supports on the table; does not permit any person to remain in the room; knocks when he wants anything, and having made his wants known gives a signal without speaking, to the person who answered his call, to retire."

Tablets have also been affixed to No. 1, Moreton-gardens, Kensington, for a short time the residence of Jenny Lind (Madame Goldschmidt), and to No. 28, Herne-hill, where John Ruskin lived from 1823 to 1843.

Prizes Offered by the Society of Dyers and Colourists.—The Council of the Society offer the following prizes for the solution of technical problems:—(1.) The Silver or Bronze Medal of the Society and £20 for a full investigation of the mordanting properties of various tanning materials, more especially—(*a*) As to the relative affinity for cotton of the tannins of galls, myrabolams, sumach, divi-divi, &c.; (*b*) as to the relative fastness of the colour lakes produced with these tannins and basic colours, in conjunction with antimony, tin, and iron; (*c*) as to the best method of determining by volumetric analysis, or other means, their relative mordanting power. (2.) The Silver or Bronze Medal of the Society for the best critical essay (not exceeding 10,000 words) on the treatment of effluents from dye-houses and textile factories. (3.) A prize of £20 for a determination of the average degree of diminution in strength of three-standard cotton yarns, *e.g.*, 2/40's American, 1/50's Egyptian, 2/120's South Sea Island, brought about by different bleaching processes. (4.) A prize of £20 for a full investigation of the average degree of tendering brought about in cotton yarn by—(*a*) cross dyeing in acid colours; and (*b*) dyeing aniline black; with the object of fixing standards for the trade. (5.) A prize of £30 for a practical method of causing kemps, when present in yarn or piece goods, to take dyestuffs equally with the accompanying wool. (6.) A prize of £20 for a practical method of dyeing full shades of basic colours on cotton fast to rubbing. (7.) The Silver or Bronze Medal of the Society and £20 for a full investigation of the influence of the various substances present in natural indigo in respect to their influence upon the dyeing of wool by the fermentation vat, and the depth, bloom, and fastness of the shade obtained. All papers, &c., sent in for competition must be delivered free, on or before December 31st, 1909, to the Honorary Secretary of the Society, Mr. Ernest T. Holdsworth, Pearl Assurance-buildings, Market-street, Bradford, from whom further particulars may be obtained. The Worshipful Company of Dyers also offer a Gold Medal to be awarded by the Council of the Society. The medal will be known as "The Dyers Company's Research Medal," and will be given for "the best scientific or technical investigation connected with the tinctorial arts" submitted to the Society for publication before the 31st December, 1909.

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FRIDAY, AUGUST 27, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY

CANTOR LECTURES.

MODERN METHODS OF ARTIFICIAL ILLUMINATION.

By Leon Gaster, A.M.I.E.E.
(Editor of the *Illuminating Engineer.*)

PART IV.*

Introduction.

In my two first lectures I have dealt with gas and electric lighting. I now propose to deal with systems of lighting which, naturally, lack some of the advantages associated with these highly-developed methods, but yet have themselves certain advantages, and notably those of portability, of being self-contained, and to some extent independent of the supply of fuel from without.

Both candles and oil lamps are of very ancient origin. Dr. Böhm (*Illuminating Engineer*, February, 1908) remarks that oil lamps of a kind were met with in the most ancient Roman illustrations, while splinters of resinous pine were used even in the age of Homer. Candles apparently were of Phœnician origin, and the Emperor Constantine is said to have illuminated Byzantium by candles on Christmas-eve in the fourth century. It is remarkable to reflect how comparatively stationary the manufacture of candles seems to have been until the last century, when the production of stearine and the ingenious invention of a wick that did not require snuffing made the candle a more practical article; it is, however, still worthy of remark that one of the witnesses (a member of a prominent firm engaged in the candle-making industry) examined before the Commission on the standard candle of this country so late as 1881, confessed that he had never contemplated any tests of illuminating power. The treatment of the wick, the quality of wax, and other details, were the subject of very careful attention, but it hardly seems to have been adequately realised that the main business of a candle was to give light.

Dishes of liquid oil and fat were employed even by the most ancient nations; we find that they were used mainly for purposes of ornament rather than for the purpose of providing actual illumination. Indeed, this use of the oil lamp prevails in many churches at the present day. I may mention as an illustration the lighting of Santa Sophia, a church in Constantinople, which Mr. J. B. Fulton recently described in an article in the *Illuminating Engineer*.

Candles, too, are still very frequently employed for decorative purposes, and for the religious and other associations connected with them, sometimes forming an essential part of the ceremonial.

In this connection I may refer to a remarkable book recently published in Vienna by von Benesch, in which an extremely interesting collection of ancient illuminating apparatus, including many tasteful designs of candle holders, oil lamps, &c., dating from the Middle Ages to the nineteenth century, is described and illustrated.

Oil Lamps.

The discovery of oil in America about 1860 led to the development of the petroleum lamp proper. Yet the early lamps were not vastly better than those that preceded them. For

* The Course consisted of four lectures, delivered on February 15th and 22nd, and March 1st and 8th. In re-arranging the material for publication in the *Journal*, the lecturer has preferred to divide it into six parts.

instance, it was not at once that wicks were devised capable of drawing up the oil from below in a satisfactory manner, and therefore lamps were provided with a reservoir placed at a higher level than the flame, thus allowing

FIG. 41.

ILLUMINATION OF CHURCH OF ST. SOPHIA BY SMALL OIL-LAMPS.

the oil to be fed by gravity. The invention of the chimney by Argand, and the draught so produced, was again a great improvement, and the substitution of a ring-shaped wick for the flat variety previously used was also an advance. Oil lamps, however, formed the standard method of illuminating streets before gas was available.

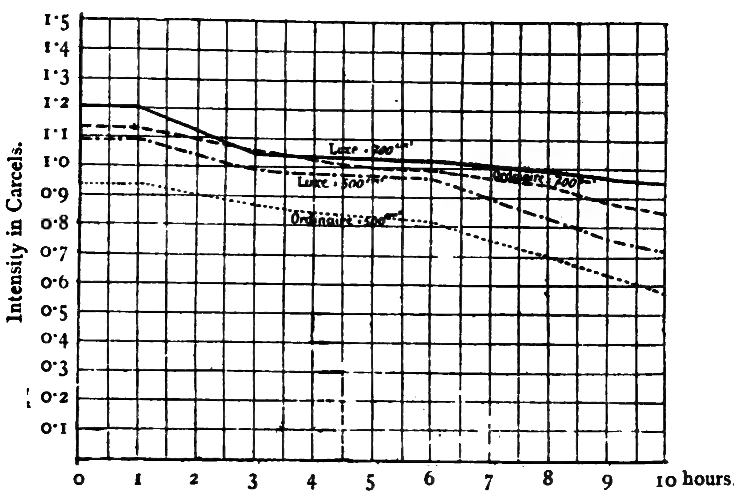
The ordinary petroleum lamp is often unjustifiably condemned for certain defects which are not inherent in it, and can be avoided by suitable design. In country districts the lamps are so widely used that there is still room for the careful study of the best methods of producing and utilising the light produced from oil even

at the present day. This matter formed the subject of discussion at the International Petroleum Congress held at Bucharest in 1907, when papers were presented by M. Aug. Pihan, Herr Proessdorf, and myself. A resolution was moved after my paper asking that the Congress should study and decide upon a type of domestic lamp fulfilling the conditions of the greatest safety and highest efficiency; and this suggestion was formally adopted.

This question of safety is indeed a very vital one to the success of oil lamps, and previous Government, last year, I believe, introduced legislation specifying the exact conditions to be fulfilled by oil used for illuminating purposes in that country. Naturally, such a specification can only be applied to the Roumanian type of oil, and might not answer if used in connection with the Russian or American variety.

M. Pihan, on this and other occasions, has presented details as to the correct method of testing oil lamps, and the paper by Herr Proessdorff, in which 150 lamps were examined, is a useful record of the research on lamps

FIG. 42.



CURVES ILLUSTRATING IMPROVEMENT IN LIGHT OBTAINED FROM OIL-LAMPS BY KEEPING LEVEL OF PETROLEUM IN RESERVOIR HIGH.

to the Congress many prizes had been offered for a lamp which would satisfy the required conditions, but without one being discovered which was considered worthy of the prize.

It may also be pointed out that the design of any particular lamp must take into account the nature of the petroleum which is intended to be used with it. For instance, a lamp intended for American oil would not serve equally well for use with the Russian variety, nor, probably, would the type of chimney favouring the best conditions of combustion be the same in the two cases. The result of trying to burn a variety of petroleum different from that for which the lamp is designed, will probably only lead to the production of incomplete combustion, a smoky flame, and a smell.

Recognising this fact, the Roumanian burning petroleum of different kinds that has recently been carried out.

Another very interesting point was touched upon by M. Guiselin (*Illuminating Engineer*, Vol. I., March, 1908), who demonstrated how greatly the light from an oil lamp was affected by the quantity of oil in the reservoir. An increase of 20 per cent. in the illuminating efficiency can be secured by keeping 700 cubic centimetres of petroleum in the reservoir, instead of 500. This can be easily understood when we remember the need to facilitate the capillary action of the wick. Consumers are, therefore, recommended to keep their lamps well filled up.

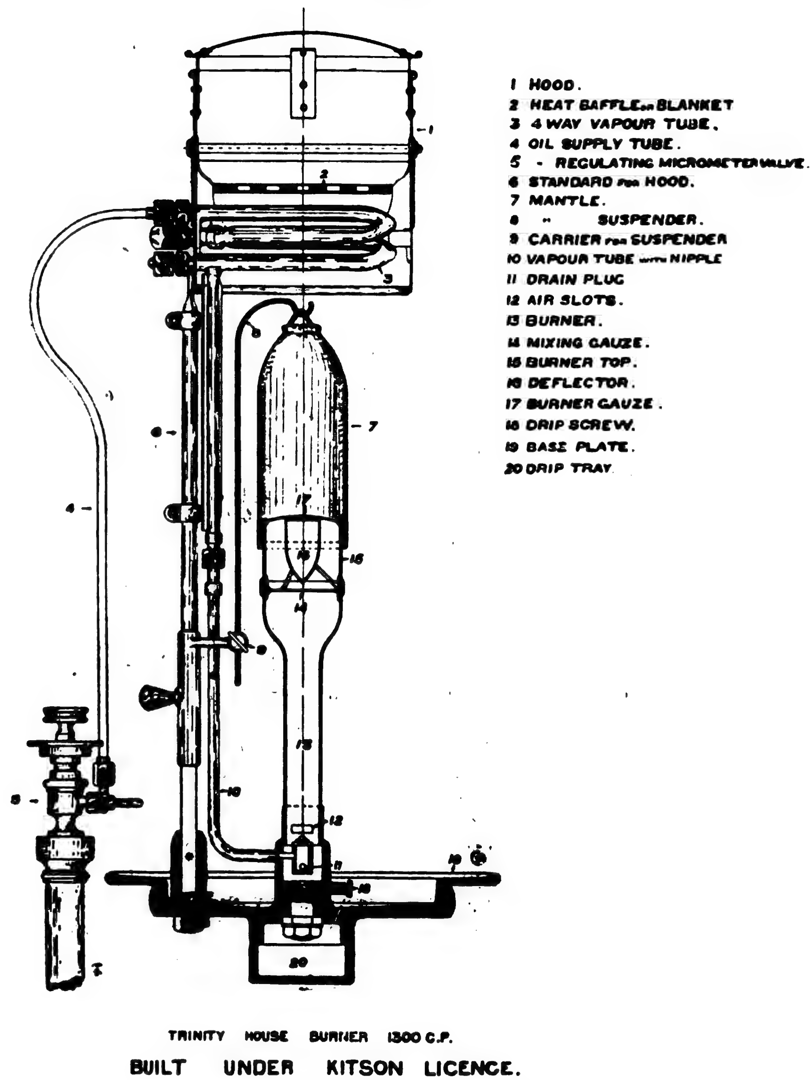
Some very complete researches on the oil lamp as a standard, were communicated by Dr. A. H. Elliott at the second annual Convention of the Illuminating Engineering Society

last year, and in the discussion the importance of careful attention to the wick was dwelt upon. One of the speakers referred to a new non-combustible asbestos type. I have the privilege of showing you to-night a new type of non-combustible wick, due to Dr. B. Monasch, and composed chiefly of carborundum. This same authority has recently contributed a study of the ordinary kitchen oil lamp, and has pointed out that the reflector commonly provided with these lamps is of faulty design.

Incandescent Oil Lighting.

The coming of the incandescent burner suggested a new method of utilising liquid fuels. It had been realised that if a liquid illuminant could be vapourised and mixed with the correct proportions of air, it might be utilised to heat an incandescent mantle, to even greater brightness than is obtained by gas of the ordinary variety, according to the calorific power of the vapour generated. One of the earliest methods of utilising petroleum in this way was the Kitson system, according

Fig. 43.



Sectional Block of Kitson Burner.

FIG. 44.

FORMS OF INCANDESCENT OIL LIGHTS. (THE EMPIRE LIGHT.)

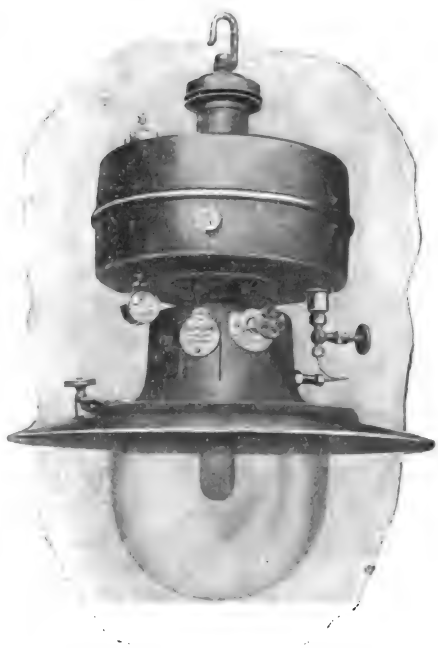
to which the petroleum was compressed at about 50 lbs. to the square inch in a suitable vessel, and then forced through a soft brass

FIG. 45.

BLANCHARD PORTABLE TABLE LAMP.

tube of very small bore into a heating vessel, and subsequently through a needle orifice to a suitably-designed Bunsen burner. This system has found a considerable field for lighthouse illumination, and especially in isolated positions for which a self-contained portable method of generation is desirable.

FIG 46.



BLANCHARD, LAMP HIGH CANDLE-POWER, COMMERCIAL FORM.

The most recent example of the Kitson system, the Empire Light, sold in England by the United Kingdom Lighting Trust, is an entirely portable, self-contained lamp, in which an improvement is introduced by

arranging the heating vessel in a vertical position quite close to the burner instead of above it.

The Blanchard system again utilises a self-contained lamp equipped with an inverted mantle, a special feature being the existence of a second vapourising chamber in which the heavier fractions of the oil can fall and be vapourised by their close connection with the mantle itself. It is claimed that one gallon of low quality paraffin oil in connection with the mantle used in this lamp will give an illuminating capacity of 18,000 candle hours. The use of an inverted burner also enables small units

FIG. 47.

THE PETROLITE LAMP.

to be supplied with greater ease, lamps yielding from 75 to 1,200 candle-power being available. An ingenious and interesting device used in this lamp is the method of registering the level of liquid in the vapouriser, which must be entirely closed and so adjusted as to withstand many times the pressure which it is likely to experience. This consists of a magnetic needle on the outside of the vessel, which is controlled by a magnetic float rising and falling with the liquid within. Lamps for outdoor lighting are stated to burn 20 hours without requiring further attention. A convenient portable form of lamp is shown in Fig. 45.

The *Petrolite Lamp*, an example of which I have also on exhibition here to-night, represents another development in this direction. In this lamp the air is sucked through a porous vessel impregnated with suitable hydro-carbons, a draught being provided by the use of a fairly long chimney. One advantage claimed for this lamp is its safety.

The principle and *modus operandi* of the petrolite lamp are essentially as follows:—The container consists of a highly absorbent and incombustible stone. This stone, which is perforated to allow for the passage of air, is placed in the container and filled with petrol, which is immediately absorbed by the stone.

When lighting the lamp, the insertion of a lighted match in the opening of the burner gallery causes immediately a slight draught in the chimney, sufficient to produce a suction in the inner burner tube. The cold air thus drawn into the lamp has to make its way through the perforation of the stone saturated with petrol. During this passage the air is being carburetted with vapour, and this diluted gas, while being drawn up the burner tube, meets on its way with a further supply of cold air from the outside. Both are automatically mixed in the exact proportion to give a very hot Bunsen flame with perfect combustion.

It is therefore suggested that the evaporation of the petrol in the lamp is not produced by heat, but by causing a draught of cold air to pass through the petrolite container. In this way the burner produces a sufficiently hot Bunsen flame for the most brilliant incandescent light, while the temperature of the lamp body is lower than that of the surrounding air, thus eliminating one of the many sources of danger.

As has been shown, the evaporation of the petrol by a draught of cold air is caused by the up-draught of the chimney. As, however, this draught can only act in the upward direction, but never in a sideways or downward direction, it is claimed that the lamp, if overturned, immediately becomes extinguished, and that, therefore, there is no danger of fire even if the whole lamp is smashed to pieces.

Its safety has been attested by the British Fire Prevention Committee, while it has also been approved by the London County Council as an emergency light for theatres and other places of public entertainment

This lamp has been subjected to very ex

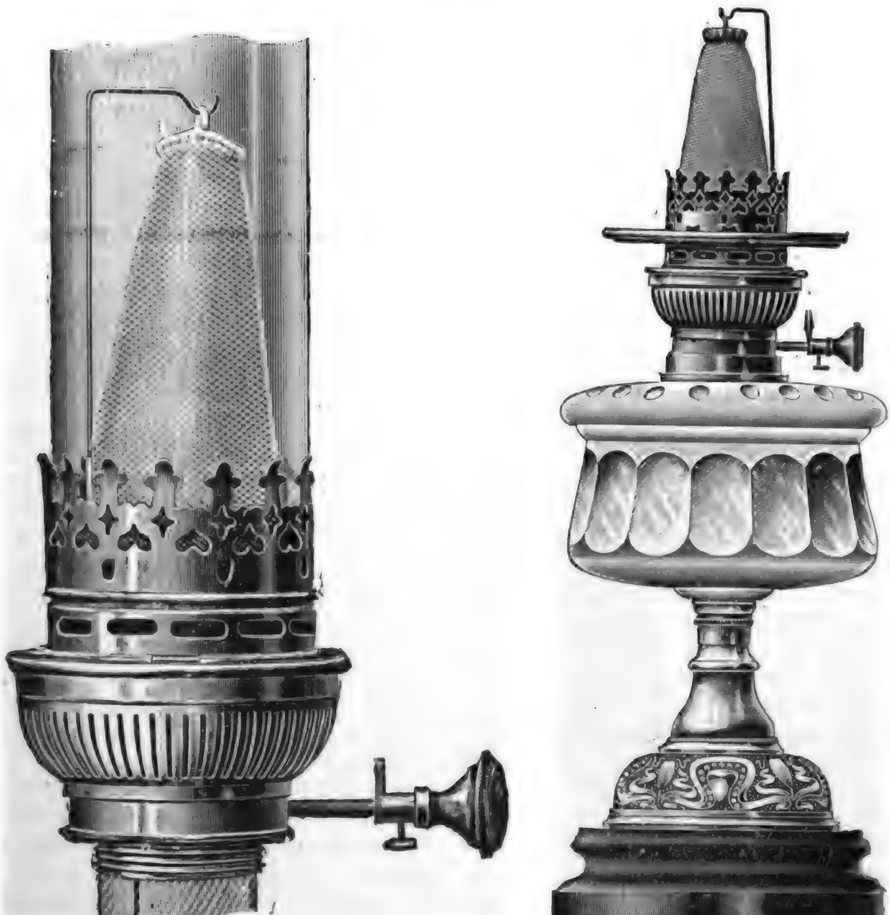
haustive tests by Professor J. T. Morris, who found that it gave a 40 candle-power light for one hour on 1⅛ ozs. of ·695 spirit at 1s. 3d. per gallon. This works out at ⅕d. per hour, or about 5 hours of 40 candle-power light for 1d.

With a double chimney the lamp gave a 58 candle-power light for one hour on 2 ozs. of the same spirit at the same price, showing cost at between ⅓d. and ¼d. per hour; this latter test giving 3·7 hours of 58 candle-power light for 1d.

Yet another form of portable incandescent lamp utilising petroleum is the Lucisca lamp of Messrs. Falk, Stadelmann and Co.

I cannot here dwell on other types of oil lamps, of which there are many more to be found in the market.

FIG. 48.



LUCISCA LAMP. (General View.)

PETROL-AIR GAS LIGHTING.

A considerable amount of interest has been aroused in what are known as "Petrol-Air Systems." They all depend on the generation of a mixture of petrol vapour with air in definite proportions, the air being passed through suitable vessels and carburetted with the illuminating gas. The actual details of the apparatus by which this is achieved vary considerably. Briefly, however, the main essential quality of all is that the mixture generated at the burner should contain a small proportion of petroleum vapour mixed with air, and that the composition of this mixture should be automatically maintained constant. The machine by which this is accomplished usually consists of a small hot-air engine, operated by the gas it pro

duces, together with a suitable blower, carburetter, and gas-holder; in some cases the motive power is supplied by a falling weight, which is newly wound up from time to time, or, where available, water power.

Such machines are designed with a view to being as easily controlled and as automatic as possible; once the engine is started, which should only take a few minutes, the apparatus, it is claimed, ought to continue its functions automatically.

One difficulty against which the system had to contend in the past was the condensation of liquid in the pipes in cold weather. In addition, in defective systems, it was found that, as the burners were turned on and off, and the load on the machine varied, the quality of gas did not remain constant, so that the illuminating value of the lights was reduced, and they tended to smoke, &c., unless readjusted. The best modern systems, however, claim to have completely avoided this difficulty by suitable design of the plant. In this connection I may refer to a discussion on the point which has recently been taking place in the columns of the *Illuminating Engineer* (August, 1909, pp. 549 and 561 to 568), in which several prominent experts connected with petrol-air lighting took part. All contended, however, that these defects were not to be found in the best modern plants.

Naturally in the time at my disposal I can only refer to a few examples which are representative of this method of lighting. By the kindness of the makers, complete working plants of the Aerogen, the Machine Gas Syndicate (Cox's system), and National Air-Gas Company's types are on exhibition. In addition to those exhibited on this occasion, which I now propose to describe, I may mention the De Laitte, Praed, Litz, Mitchellite, and Loco systems, which, however, do not by any means exhaust the types available.

Aerogen Gas (Messrs. Strode and Co.).—Aerogen gas is claimed to be a perfectly uniform mixture, the machine being constructed to keep the percentage of hydrogen vapour per cubic foot of air constant. The petrol-feed and the air compressor work in unison, so that the proportions of petrol and air never vary. The carburation and compression are effected simultaneously in the same chamber, and an even temperature is maintained in the generating chamber by means of the water contained therein.

The petrol is lifted from the petrol chamber and discharged into the carburetting chamber as required, so that there is no possibility of its being flooded by an excess of petrol. A small gasholder is provided which serves as an antifluctuator and maintains a uniform pressure.

The whole mechanism is self-controlled. The machine works quickly when the maximum output is required, and slowly when little gas is used, and stops automatically when no more gas is required. The gas mixture consists of 95 per cent. of atmospheric air and 5 per cent. of petrol vapour, this percentage being maintained automatically by the mechanism under all conditions.

As advantages of the method it is claimed that (1) the gas has a high illuminating power, thus enabling the gas consumption to be small; (2) small sized pipes can be used to convey the gas to the burners; (3) additional air being drawn in by the burners during combustion has a cooling effect on the burner, thus maintaining a longer life for the mantles and burners than can be obtained with gas of a poorer quality; and (4) owing to the small amount of gas consumed the consumption at the burners is silent.

With the motor-driven apparatus a specially constructed gas-meter is provided through which the gas passes. This meter records the amount of gas used and controls the petrol feed. When all lights are turned out the production of gas is regulated to keep the motor running only.

The makers state that aerogen gas can be stored in any quantity, and is not liable to condensation When storage holders are used for country house lighting, an automatic valve is provided so that when the general lights are turned out the holder is fully charged, and the gas supply to the motor automatically turned off, stopping the working of the apparatus, and leaving the storage holder to supply any lights required during the night or in the morning, without the necessity of running the engine.

With the weight-driven machine the light is always available, so that there is no necessity for a storage holder, and economy is effected by dispensing with the motor, thus saving consumption of gas to drive the motor. The weights can be supported from a side wall, or suspended over a disused well, the required drop being from 25 to 30 feet. A steel gantry can be provided to carry the weight where a wall or well cannot be made use of.

It is further stated that the gas can be transmitted for long distances, installations being

in use where the gas is transmitted a distance of over eight miles.

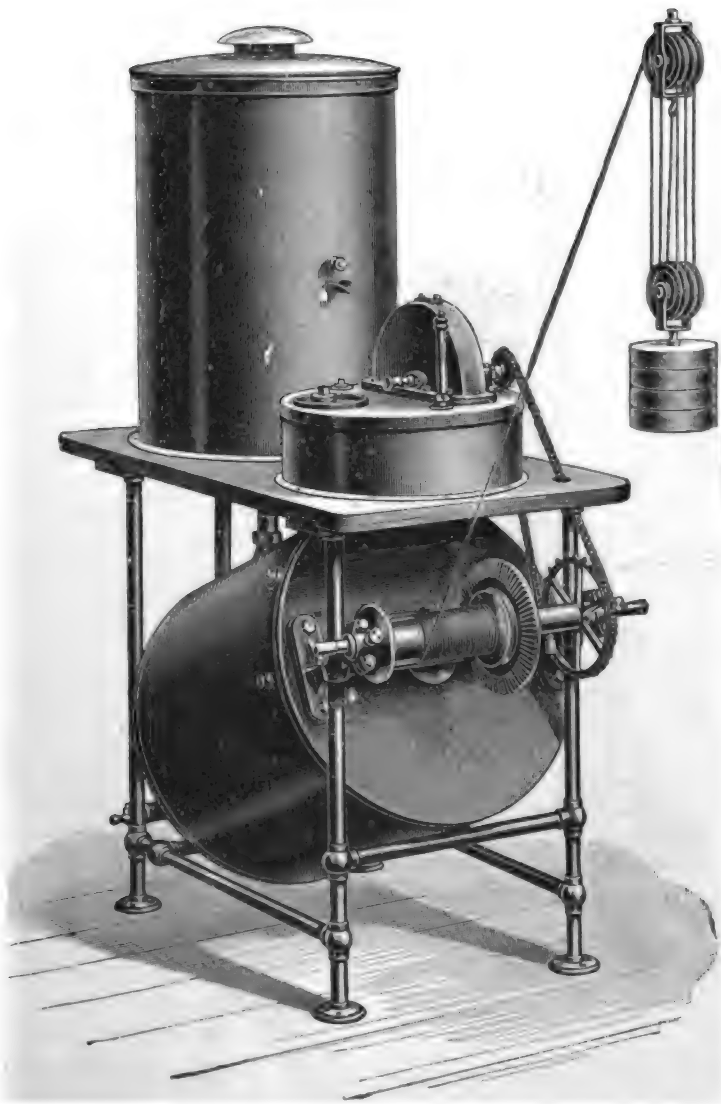
Aerogen gas has a specific weight of 1·2 compared with air. Its odour is not unpleasant, but is distinctly perceptible in cases of escape. One gallon of petrol is said by the makers to produce 520 cubic feet of gas, and three cubic feet of gas, used with an incandescent mantle, to yield an illuminating power of 40 candle-power.

A general view of the weight-driven and water-driven plants will be obtained in Figs. 49 and 50.

Cox's Air Gas System (The Machine Gas Syndicate, Ltd.).—The demonstration given of this method is mainly intended to show the absence of condensation. The main outlet of the machine, Fig. 51 (No. 12 in Fig. 51), is connected on to a coil, which is immersed in ice and salt, and kept at 15° C below zero the whole time during the lecture; nevertheless it will be seen that the light appears to be unaffected. Cocks are fitted in the coil at various bends, and anyone can satisfy himself by opening one of them that no liquid has collected.

The machine, as illustrated in section, may

Fig. 49.



Aerogen Weight-driven Petrol-Air Gas Plant.

be briefly described as follows:—The petrol-container is at the top and numbered 8 and 9, the inner vessel containing the petrol, and the outer one water for sealing the floating bell, 9. The safety of this arrangement is claimed to lie in the fact that there is no possibility of the container bursting, the bell 9 following the displacement of petrol as it is used in the machine. After starting the machine, petrol cock 23 is turned on full and feeds through pipe 22 to valve 21, which is controlled by levers 30 and 20, lever 20 being controlled by the position of holder; the petrol passing valve 21 is conveyed down pipe 28 and drips on to grid 3 which rotates; this grid is so constructed that each drop of petrol is spread into a thin film. When started the hot-air motor drives blower 13; the air is drawn in at the inlet, passed round the jacket of hot air engine, and along casting 1, through the grid in the carburettor. In this process it collects all the vapour and evaporates the films found on the grid, and passes up through pipe 4, through valve 5 into the gas holder. The amount used or drawn from the holder 7 determines the position of this holder, which in turn controls the delivery of petrol and air to the carburettor by means of the connections, 20, 24 and 25. (See Fig. 52.)

This machine is claimed by the makers to be very simple in operation, and within the understanding of almost anyone, care being only required in keeping it clean and lubricating. In addition it is stated that the machines have been found to work quite satisfactorily under very varied climatic conditions.

Fig. 50.

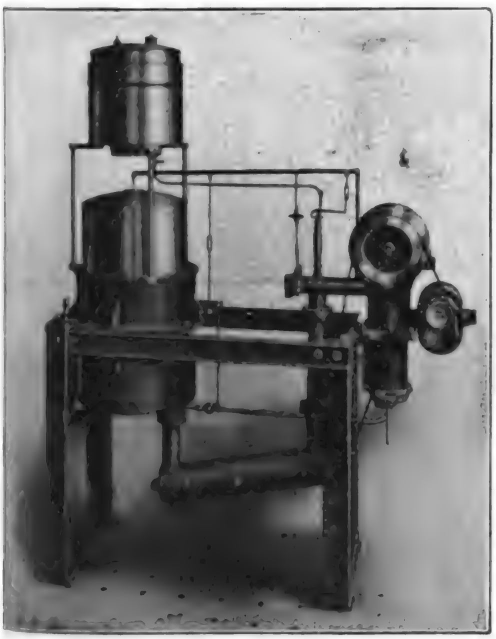
Aerogen Water-driven Petrol-Air Gas Plant.

National Air-Gas System.—An illustration of this method of petrol-air gas lighting is afforded by the apparatus which, by the kindness of the makers, I am privileged to be able to show you this evening. This

method utilises also about 1½ per cent. of petrol vapour, and it is stated that 1,600 cubic feet of gas are produced per gallon of petrol costing 6d. The essential details of the method are connected with the method of obtaining a uniform gas from the carburettor, where the air is charged with petrol vapour. This uniformity must, of course, be maintained, even though the differences in the flow and volume of the air passed through are very great, and there are considerable fluctuations in temperature.

In this method a hot-air engine and air blower are utilised in order to generate the gas, and special arrangements are necessary in order to control the admission of air. This is now accomplished by a thermostatic control, which is arranged to admit automatically spread supplies of carburetted and non-carburetted air. There is also a relief air-valve by which the air is allowed to escape when not actually required for the production of gas. In addition, it is stated that the quality of gasoline used is particularly safe.

FIG. 51.



AUTOMATIC PETROL-AIR PLANT. (Cox's System.)

One result of the small amount of petrol vapour mixed with the air is claimed to be that the products of combustion are less poisonous than in the case of gas, and it is said that the apparatus has even been successfully applied to the lighting of greenhouses, &c.

The general nature of the process by which gas is generated will be understood from Figs. 53 and 54. The apparatus mainly consists of a hot-air engine, an air blower, a vertical cylinder containing the supply of petrol, and a carburettor connected by a series of pipes and valves to a small gas holder, the whole being self-contained and perfectly automatic in working. (See Fig. 54.)

The engine is actuated by a burner, 20, consuming gas produced by the apparatus, and this drives the blower, I. After leaving the blower the air is divided into two streams, the right hand supply passing to the valve, M; the supply on the left flows direct to the carburettor, in its passage through which it is caused to impinge on the surface of the petrol and becomes impregnated with proportionately more or less vapour, according to the amount of gas being used. Thus, if only a small quantity is being consumed, only a small volume of air is passing slowly over the given surface of oil in the carburettor, and becomes impregnated with a large amount of vapour, and therefore requires diluting in the mixing-box, N, to a very considerable extent by air from the air valve, M, in order to bring the proportion of hydrocarbon vapour down to 1½ per cent. of the whole. When a large number of burners are turned on, a large volume of air with a greater speed of flow is passed over the same given surface, and, as the time during which it is in contact with the petrol is far less than when only a small quantity was being used, it necessarily contains less hydrocarbon vapour, so that a proportionate part of the volume of air passing into the mixing-box requires to be cut off in order to keep the mixture uniform. This is done automatically in the following manner:—

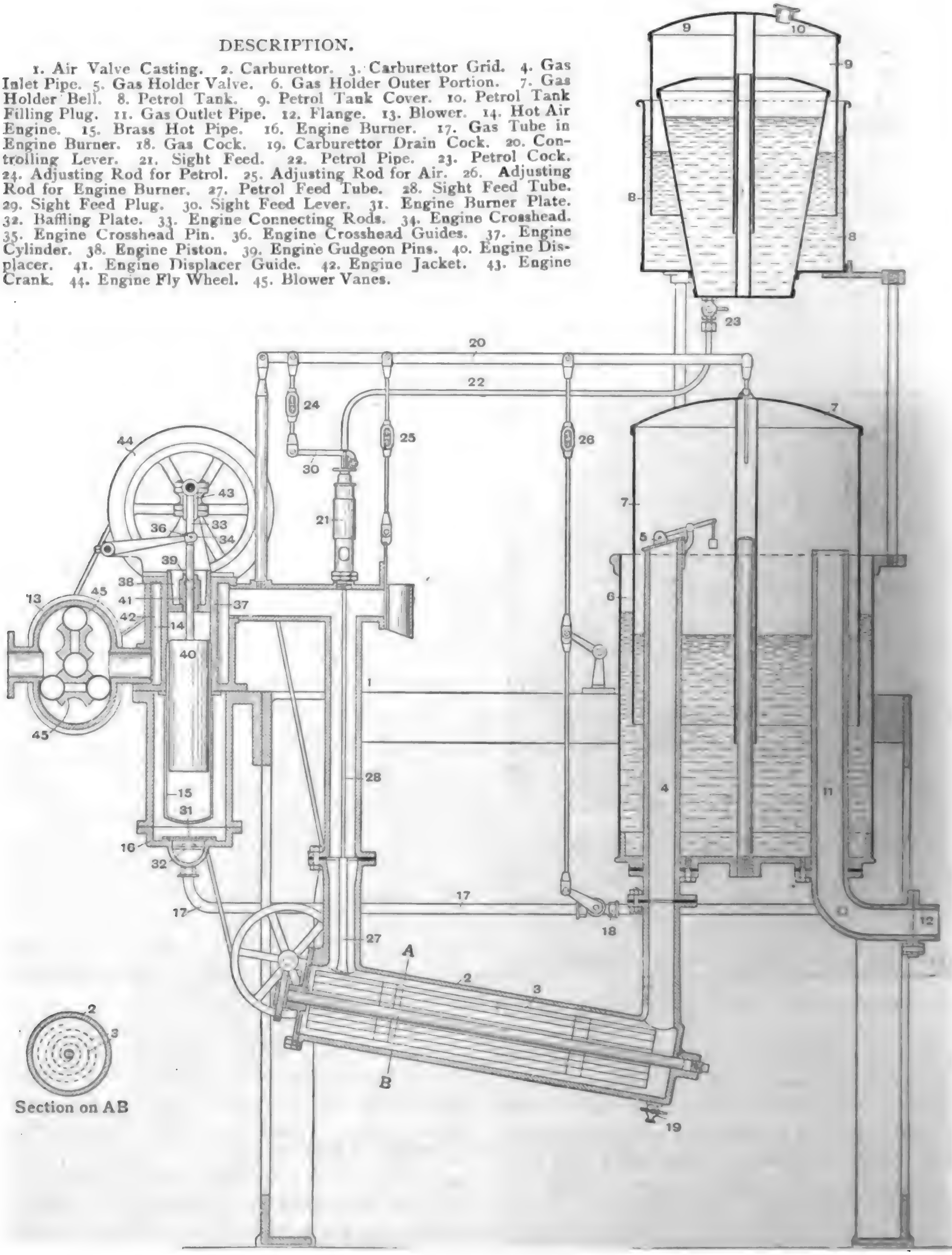
The air valve, M, and the gas valve, O, which work in contrary directions, are connected to, and are operated by, the rise and fall of the bell (or upper part) of the gas holder, which is controlled by the main valve, Q. Thus, if more burners are turned on, the holder falls, and proportionately closes the air valve, M, and opens the gas valve, O. When the burners are turned off the reverse action takes place, and thus a uniform gas is obtained under varying demands.

In order to replace the heat lost in vapourising it, and to keep the petrol of a normal specific gravity, the heated water from the cooling jacket of the engine is circulated through a chamber underneath the carburettor, and the heat abstracted (which is

FIG. 52.

DESCRIPTION.

1. Air Valve Casting. 2. Carburettor. 3. Carburettor Grid. 4. Gas Inlet Pipe. 5. Gas Holder Valve. 6. Gas Holder Outer Portion. 7. Gas Holder Bell. 8. Petrol Tank. 9. Petrol Tank Cover. 10. Petrol Tank Filling Plug. 11. Gas Outlet Pipe. 12. Flange. 13. Blower. 14. Hot Air Engine. 15. Brass Hot Pipe. 16. Engine Burner. 17. Gas Tube in Engine Burner. 18. Gas Cock. 19. Carburettor Drain Cock. 20. Controlling Lever. 21. Sight Feed. 22. Petrol Pipe. 23. Petrol Cock. 24. Adjusting Rod for Petrol. 25. Adjusting Rod for Air. 26. Adjusting Rod for Engine Burner. 27. Petrol Feed Tube. 28. Sight Feed Tube. 29. Sight Feed Plug. 30. Sight Feed Lever. 31. Engine Burner Plate. 32. Baffling Plate. 33. Engine Connecting Rods. 34. Engine Crosshead. 35. Engine Crosshead Pin. 36. Engine Crosshead Guides. 37. Engine Cylinder. 38. Engine Piston. 39. Engine Gudgeon Pins. 40. Engine Displacer. 41. Engine Displacer Guide. 42. Engine Jacket. 43. Engine Crank. 44. Engine Fly Wheel. 45. Blower Vanes.



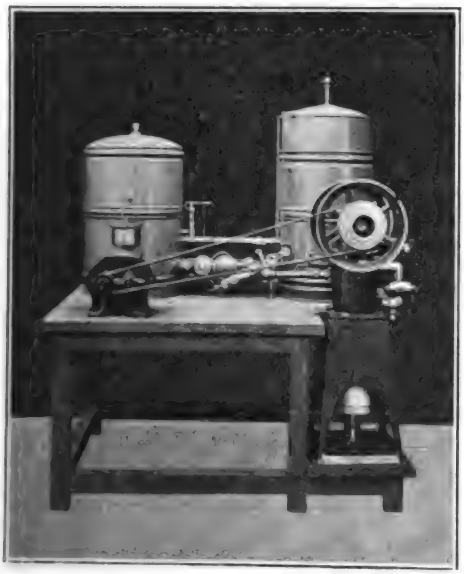
Sectional View of Machine Gas Syndicate Petrol Air-Plane. (Cox's System.)

greater or less, according to the quantity of gas being made) is thus replaced. The temperature of the water is controlled by automatically cutting down the supply of gas to the engine burner, this being the source of the heat, according to the number of burners in use. A constant level is maintained in the carburettor, the petrol being supplied automatically as required from the tank, C, by means of the float feed, A.

Petrol-air plants are intended mainly for use in remote country districts, &c., where gas or electricity is not available. However, an interesting development seems to have been recently recorded in Romford, where a number of adjacently situated shop-keepers propose to co-operate and erect a common air-gas generator, anticipating that the result will be cheaper than the local gas supply.

But it is still mainly in districts where electricity and gas are not available that petrol air-gas plants are particularly acceptable, for example, in the lighting of country residences.

Fig. 53.



National Air-Gas Plant. (General View.)

This is a field for which acetylene has also great merits, and there is, therefore, naturally some competition between these two illuminants. A *résumé* of the merits of both methods, may be found in the recent communications to the *Illuminating Engineer*, to which reference has already been made (August, 1909), and also in a paper by Mr. C. Bingham and some correspondence which followed, published in the same journal in the previous year (Vol. I., 1908, p. 547).

One thing may be said with certainty, however. A consumer who contemplates installing a plant of this kind would do well to go to a thoroughly reliable firm, and ensure that he receives the best workmanship available. With a plant of this kind, the daily running of which depends upon his own exertions, success is only attained when the arrangement runs practically automatically and smoothly. The result of poor workmanship or old-fashioned apparatus may be continual trouble and inconvenience to the user. For instance, reference has been made to the fact that, unless this is properly provided against, condensation in the pipes is apt to occur in cold weather, and the householder may find his lights fail on a frosty winter's night.

Most of these systems claim that 1,000 candle-power hour can be produced at a cost in the neighbourhood of one penny or even less; and with petrol at its present price, there can be no doubt of the cheap running costs of such systems.

Naturally, precautions have to be taken as regards the storage of such an inflammable substance as petrol. The fire insurance companies insist upon the actual plant containing the petrol being installed outside the house; it is, therefore, obviously desirable to utilise a form of generator which should be absolutely automatic, and should require attention at not too frequent intervals.

On the other hand, the actual gaseous mixture in the pipes is admitted to be usually of such a composition as to render it almost impossible for an explosion to occur, and the smell of escaping gas, though distinct, is said not to be unpleasant. In the case of such gases as ordinary town gas and acetylene, on the other hand, it is of course admitted that the production of an explosive mixture, owing to an escape, is a possibility, though accidents due to this cause are now certainly very rare.

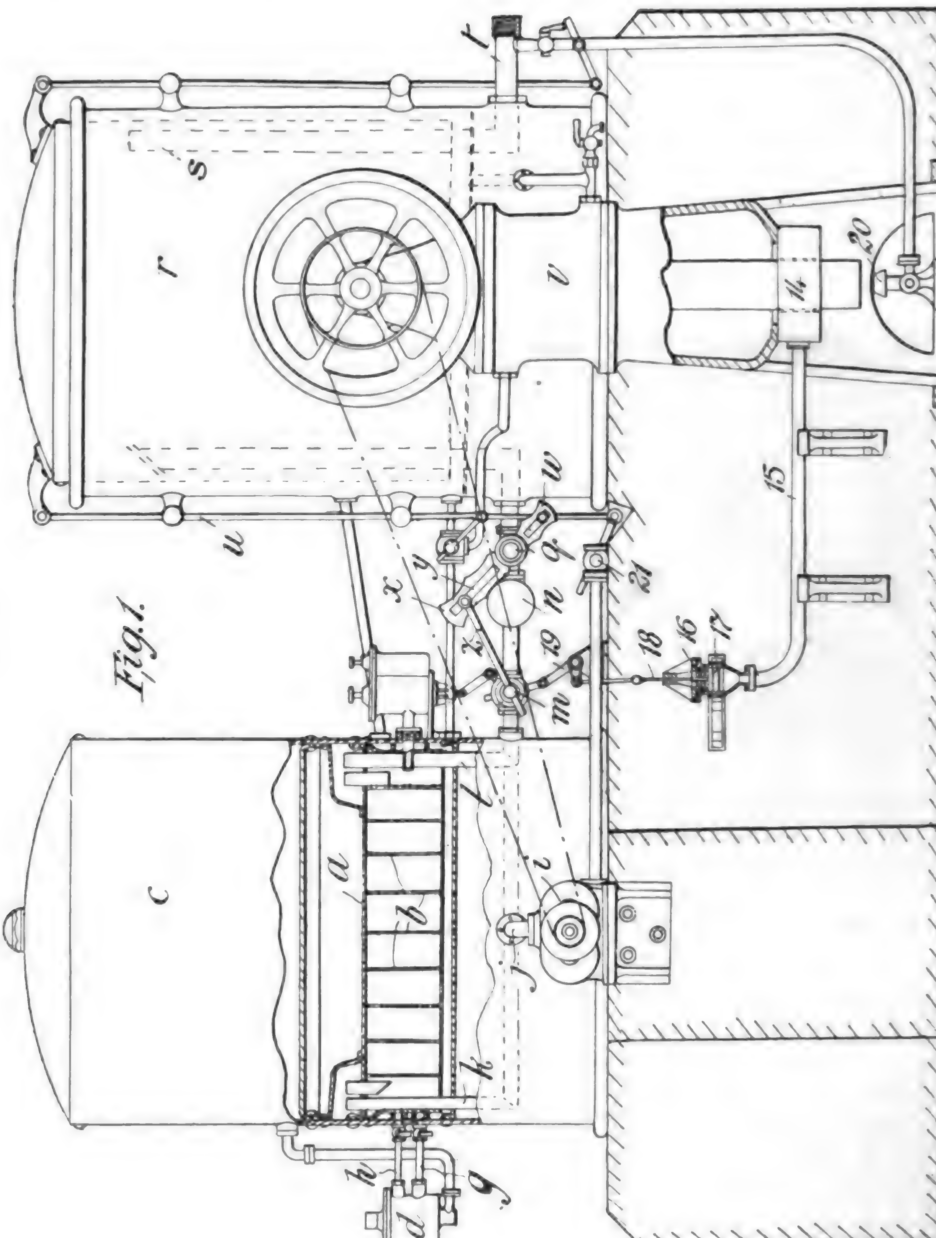
Alcohol and other Self-contained Methods of Incandescent Lighting.

While dealing with self-contained lamps using liquid fuels, some mention should be made of lamps using alcohol. The coming of the incandescent mantle led to the development of a number of lamps of this kind, some using a wick to bring the alcohol to the incandescent burner, and others depending upon a suitable gasifying chamber and a draught.

Fig. 55 shows an illustration of a spirit lamp of the wick type which is taken from an interesting little book on this subject recently published in Germany (W. Brusch, "Die Beleuchtungsarten der Gegenwart"). The support of the incandescent mantle in this case consists of copper, brass, or any good conducting metal. It is arranged to bend round the burner nozzle and partially to encircle the wick tube. In this way a portion of

the heat of the flame can be communicated to the alcohol. The admission of vapour to the burner can be regulated by an adjuster controlling the orifice at the nozzle; it thus passes

FIG. 54.



NATIONAL AIR-GAS PLANT. (Sectional View.)

through the nozzle and is ignited above the gauze in the usual way.

When the lamp is first kindled it is necessary to promote the formation of vapour by preheating. This is done by applying a match at the hole shown in the figure at *b*. Regulation of the admission of air is accomplished by turning the ring *c*.

In the case of lamps intended for outdoor lighting a somewhat different arrangement is necessary, because it is advisable to restrict the apparatus obstructing the light in a downward direction to a minimum. Vapourising arrangements are therefore inserted above the burner. An outdoor lamp of this type, as made by Messrs. Schuchardt and Co., of

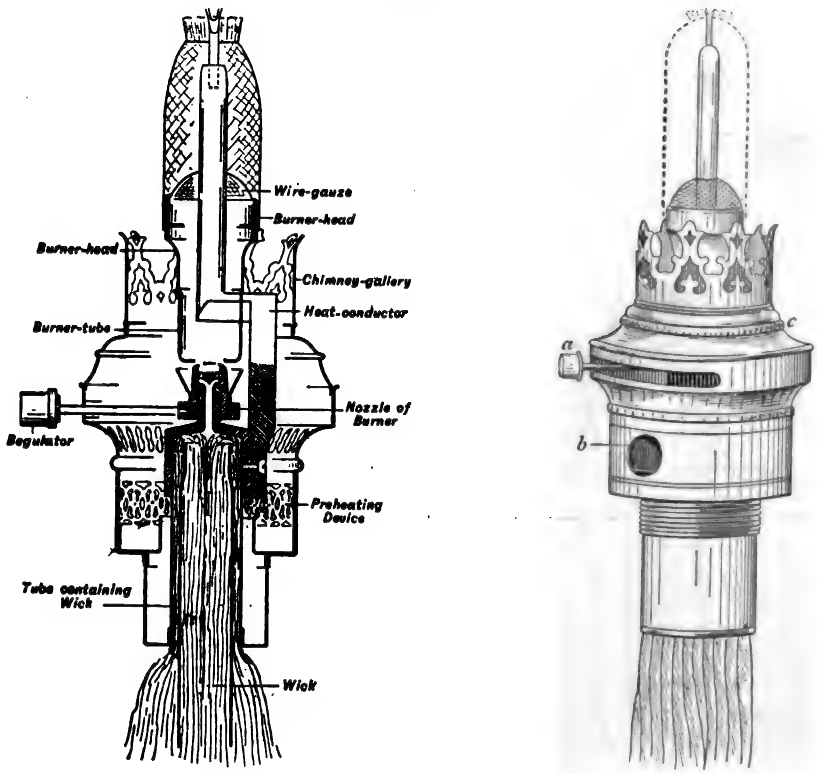
Berlin, is shown in Fig. 56, which is taken from the source previously quoted. The spirit is poured in the vessel through the orifice. When the chain *o* is pulled the cock at *h* is opened, which allows a certain amount of spirit to pass through the tube into the pre-heating chamber *g*; by the second tube *k* the spirit is also allowed to pass into the vapouriser *a*. This consists of a tube filled with asbestos, which promotes a uniform vapourisation of the spirit. The vapouriser is thus heated by the flame at *g*, which is kindled by insertion of a match through the funnel-orifice at *l*.

A pull at the chain *z* cuts off the supply of spirit at *a* and thus extinguishes the flame. It may also be mentioned that the supply of vapour generated is automatically controlled. A strong evolution of gas forces back the liquid in *a*. The intensity of this lamp is stated to be about 75 candle-power, the consumption of spirit per hour being about 140 c.c.

Alcohol has several advantages for use as an incandescent illuminant. Unlike petrol and petroleum, which contain a somewhat uncertain composition of various hydro-carbons of different specific gravity, alcohol has a constant composition, consisting of liquid of the formula C_2H_5OH. This theoretically should make it easier to produce a perfect type of burner, and complete combustion. In addition, while alcohol is admittedly not a very inflammable liquid, and will not easily vapourise, it has also the property of mixing with water, and is, therefore, readily extinguished by a water douche. In many countries, again, there is no natural oil supply, but on the other hand, the agricultural possibilities of the locality make it an easy matter to secure a supply of alcohol for illumination. One difficulty in this respect, of course, is the question of suitable adulteration of the alcohol so as to render it unfit for human consumption. In Russia, in the past, alcohol intended for burning has frequently been purified from the adulterating constituents, and afterwards sold for drinking; the Russian Government, however, offered very high prizes for the discovery of a method of adulteration which could not be nullified in this way.

In passing, a few words may be said about

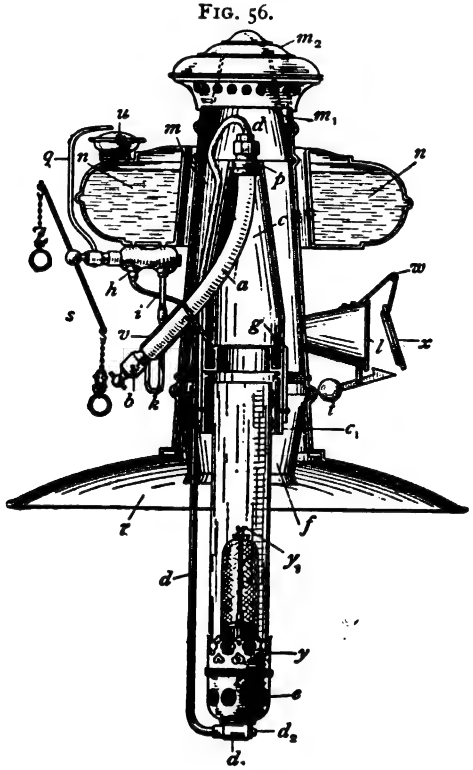
Fig. 55.



Alcohol Incandescent Lamp, with Wick.

the use of various other systems of liquid fuels, which have been found of considerable value for lighting railway carriages, &c., and in other cases where portability is extremely desirable. In these systems various hydrocarbons are frequently liquefied under considerable pressure, stored in cylinders, and may then be carried about at any particular destination. One of the oldest systems in this country is the Pintsch oil gas system in which oil gas is subjected to a pressure of 6 to 7 atmospheres per square inch.

Fig. 56.



Alcohol Incandescent Lamp, with Vapourising Chamber.

The Blaugas again is a special liquid illuminating gas produced by distillation of minerals, such as crude petroleum. The gas is then compressed at the exceptionally high pressure of 100 atmospheres.

Yet another system of a kindred nature is the Wolf gas, which has been described in the *Illuminating Engineer* (Vol. I, 1908, page 681), and a specimen of which, through the kindness of Dr. Achner, is on exhibition to-night. You will be able to form your own conclusions as to the compact nature of the apparatus. This gas consists mainly of such hydro-carbons as ethylene and ethane, and it is claimed to be influenced to an exceptionally small extent by external temperature.

Most of these gases have been rendered much more useful by the coming of the incandescent mantle, for some of them are credited with an exceptionally high calorific value; this leads to a high efficiency in the burner, Wolf gas being credited with about 60 to 70 English candle-power per cubic foot of gas consumed per hour.

Acetylene Lighting.

Introduction.—I must now turn to an illuminant which has made immense strides of recent years, namely, acetylene. For a more complete sketch of this method of lighting, I must refer you to the well-known Cantor lectures of Professor Vivian Lewes on the subject.

Acetylene lighting has only been developed to perfection by dogged perseverance, and many were the difficulties which early workers in the field had to contend against. For instance, acetylene itself seems to be an especially sensitive gas which it was difficult, at one time, to procure in a state of purity, and which tended to form "polymerides," possessing undesirable qualities, such as unpleasant odour, and explosive tendencies.

In addition, impurities such as phosphone rendered the gas liable to spontaneous combustion, and were also said to be responsible for the slight haze which used, at one time, to accompany the burning of acetylene in a room. Again, a mixture of seven of air to one of acetylene is very explosive. Nowadays, however, very careful purification has removed many of these defects, and attention to keeping the generator cool, and other matters, has prevented the tendency to polymerise to a great extent. To-day it is possible to burn acetylene without much smell, and it is said that the gas itself could be rendered absolutely odourless were it not for the danger attaching to such a gas, which would, of course be liable to escape without detection in the event of a leak.

In passing, it is interesting to recall that some of the early work in connection with acetylene was done in this country. Humphry Davy in 1836 studied the subject, and afterwards Berthelot in 1866 took the matter up and showed the complexity of the re-actions taking place in its combustion. Subsequently in 1892 Moissan published the results of some experiments of the manufacture of carbide

with the electric furnace, and experiments were also made by Wilson in the United States and the late Mr. Worth in this country.

Notwithstanding the early work in this country it may be noted that the actual amount of carbide manufactured here is extremely small in comparison with that in most other European countries and in the United States. For instance, according to "The Annuaire International de l'Acétylène" for 1908, the United States heads the list with 35,000 tons per annum, and the other countries follow in the order named, Italy, France, Austria-Hungary, Switzerland, Sweden, Norway and Portugal, Germany, and, lastly, Great Britain with only 1,000 tons.

I should also like to draw your attention to the striking example of the co-operation between those interested in different branches of science that the production of acetylene affords. The hydraulic engineer is interested in the water-power which is almost invariably used for carbide manufacture, the chemist and physicist are interested in the problem of its manufacture and combustion, and the illuminating engineer finally is interested in the use of the light obtained. Curiously, too, it is from water that the power to manufacture carbide is obtained, and it is with water that this carbide gives off acetylene gas; the person carrying a tin of carbide in his pocket can be said, in a very literal sense, to be carrying bottled-up natural energy.

Generating Apparatus.—The development of the generators themselves does not fall strictly within the scope of my lecture. It was at one time the subject of discussion whether the carbide should be allowed to fall into water, or whether water should be allowed to drop on to the carbide. At the present day both methods are employed, and there are varieties of apparatus which show a gradual gradation from one type to the other. In the "Annuaire International de l'Acétylène," an interesting compilation of information relating to this method of lighting for 1908, some account is given of the different types of generating apparatus in use in France and other countries. In France and Italy methods depending on the dropping of water on to carbide prevail, while in Switzerland and Holland, on the other hand, the carbide to water system is predominant.

The general nature of a modern automatic generating plant will be understood from Figs. 57 and 58, which illustrate that exhibited this evening by the Standard Acetylene Co. The principal parts of the plant are as follows:—A, the generator; B, the washer; C, the holder and tank; D, the purifier. When the plant is in action water is allowed to flow from the tank, E, through the valve, U, into the generator, A. The acetylene produced then passes through the washer, B, into the bell, at C, thus causing it to rise.

When the holder is about half full, the control tap, U, is automatically turned off and no more gas is generated. As the acetylene is used up, however, the bell will fall and turn the control tap on again, so that once more generation takes place. This automatic action goes on until the charge of carbide is exhausted. Meanwhile the gas used for burning passes out of the holder through the purifier, D, on to the burner.

One feature of this plant is that two distinct generators are provided, as shown. When one generator is worked out it can be cut out of action to receive attention. When recharging the first generator on the left, the second tap, W, would be opened so that the water could pass into the second generator on the right, and the first tap, W, is closed. The cover of the first generator may then be removed, the sludge run off through the cock, G, the generator cleaned out, and a fresh charge inserted. Various drain-pipes, S, S, S, ... are provided to run off any accumulated water.

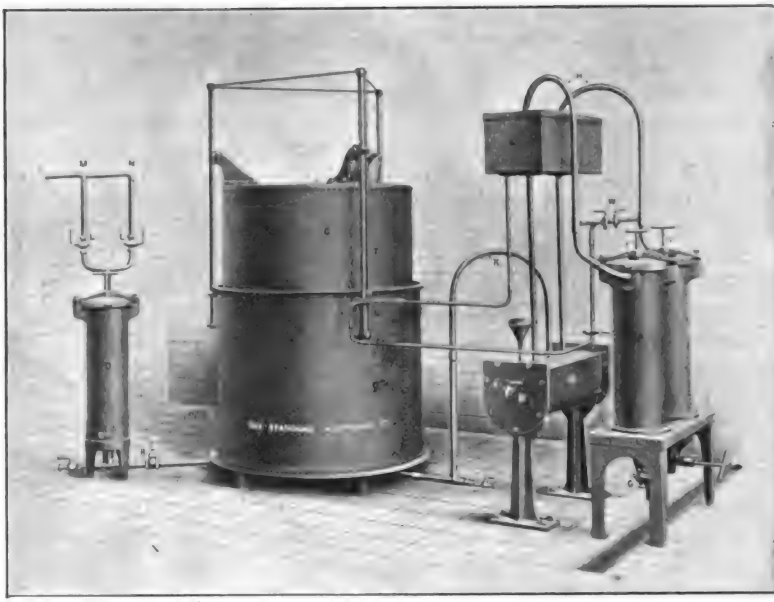
More recently quite a number of ingenious improvements have been introduced, one method, the "Brikettide" system, utilising briquettes composed of granular carbide compressed into cakes with some inactive binding material. For these briquettes it is claimed that they are not hydroscopic and, therefore, do not deteriorate in quality with time and storage, and also that they immediately cease to evolve acetylene when withdrawn from the water. The inconvenient tendency towards "after-gassing," which resulted in the accumulation and ultimate escape of gas when the generator was turned off, was thus claimed to be avoided. Similar efforts in this direction had previously been made. For instance, the carbide was compressed into cakes and coated with paraffin or sugar.

Acetylene Burners.—The design of the acetylene burners has recently been improved to such an extent as to remove many of the early troubles to a great extent and notably in the direction of avoiding their tendency to become choked up. One cause for this habit of early burners was the fact that metal was

used. Nowadays, refractory materials, such as steatite, are used. One notable improvement has been the introduction of a burner in which two flames at an angle play upon one another; the flame temperature and efficiency is increased thereby, and it is also claimed that the tendency to choke is less. The modern acetylene burner probably yields about 30 candle-power per cubic foot of gas per hour.

Another direction in which notable developments in acetylene have been introduced is its application to incandescent mantles. The acetylene flame so produced is extremely hot, and this leads to very efficient results, perhaps as much as 100 candle-power per cubic foot of gas per hour being obtained in special cases; unfortunately, this very high temperature causes mantles to deteriorate somewhat

FIG. 57.



ACETYLENE PLANT (the Standard Acetylene Company), General View.

FIG. 58.

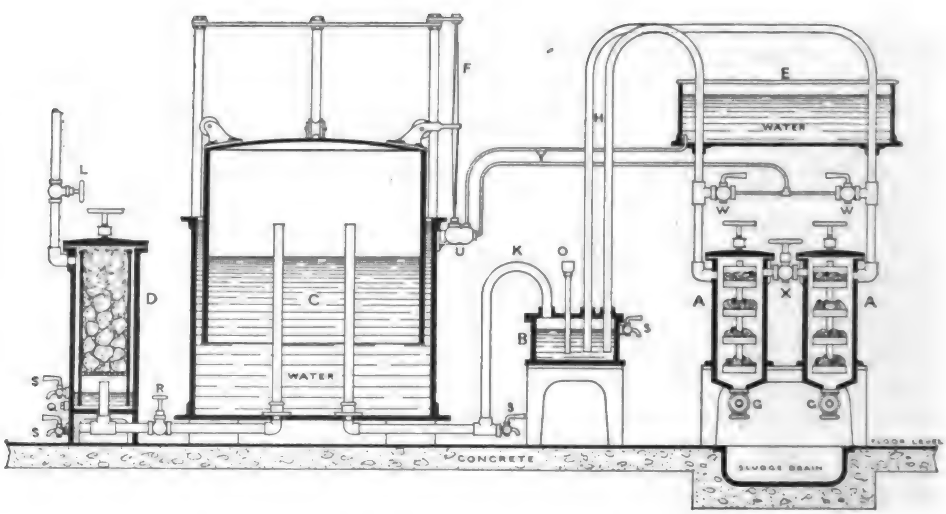
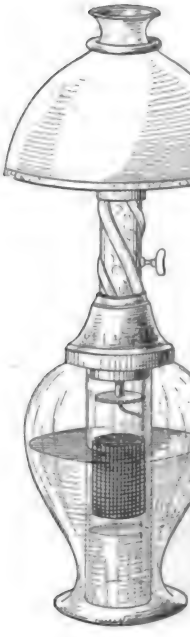
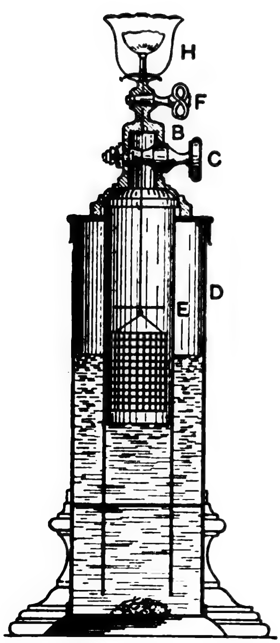


FIG. 59.



TROUVÉ PORTABLE ACETYLENE LAMP.

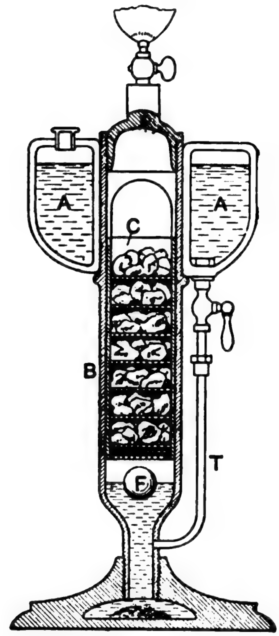
FIG. 60.



TÜRR PORTABLE ACETYLENE LAMP.

rapidly, and it has been found necessary to make them exceptionally small and stout. It has been claimed that the Hella Bushlight, of which we have an example on exhibition, is specially suitable for the acetylene flame, as the refractory needles of which it is composed are able to stand the temperature better; the durable nature of this mantle is also said to render it particularly serviceable for portable lights, for which liquid fuels are, of course, specially intended.

FIG. 61.



CERCKEL PORTABLE ACETYLENE LAMP.

Portable Acetylene Lights. — Portable acetylene lights are of comparatively early origin. The chief difficulties experienced have been connected with the regulation of the pressure and the provision of means of checking surplus evolutions of gas and "after-gasing." Some forms of portable lamps are shown in Figs 59, 60, and 61, which are taken from the before-mentioned "Annuaire Internationale de l'Acétylène." The early Trouvé pattern of lamp (Fig. 59) could not be regarded as practical to-day as there were not adequate methods to check over-production of gas. An improved form lamp due to M. Türr is shown in Fig. 60. It will be seen that by turning the knob at C the vessel containing carbide at E can be raised or lowered in the surrounding water which enters from the outer vessel, D.

The cock, F, merely serves to control the flame at H.

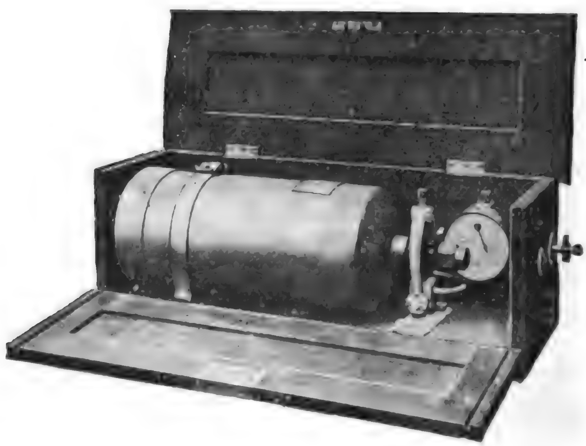
In the Cerckel lamp shown in Fig. 61, again, the water in the reservoir, A, is allowed to fall through the pipe, T, at intervals, so as to flood the carbide within the vessel at B, compartment by compartment. When the level at C is reached, the charge needs renewal.

Many other forms of improved lamps have been introduced equipped with very ingenious devices to control the evolution of gas. Portable lamps have, of course, found a great application for cycles and automobiles; the first lamp of this kind is stated, in the above mentioned periodical, to have been introduced by Mr. Itier, about 1898. They have also been applied with success to the lighting of mines and collieries. One advantage which they are claimed to possess in this connection is that the acetylene flame is stiffer than an oil one, and is therefore not so readily extinguished by a gust of wind. It is also pointed out that an acetylene flame, for a given amount of light, consumes a relatively small amount of oxygen as compared with oil, and therefore does not so readily vitiate the atmosphere in restricted spaces.

Dissolved Acetylene.—I may next refer to what is perhaps one of the most interesting directions in which acetylene has progressed, namely, its preparation in a liquid condition. The convenience of dissolved acetylene was early realised, but there were many initial difficulties to overcome, and not a few serious explosions. Dissolved acetylene, however, can be utilised to-day under a pressure of ten atmospheres if certain directions are observed, including the insertion of some suitable porous substance into the containing vessel. (Fig. 62.)

More recently a much greater development has been achieved through the use of the comparatively cheap liquid acetone, which possesses the remarkable property of dissolving about 240 times its own volume of acetylene at a pressure of 10 atmospheres, and a temperature of 15 degrees. Such a vessel of acetone saturated with acetylene gas at this pressure will, therefore, liberate 215 times its own volume when the pressure is reduced to ordinary atmospheric value. Tubes of one litre capacity, containing about 100 litres of acetylene have been proved to be of very great value where portability is the chief consideration.

FIG. 62.



DISSOLVED ACETYLENE OUTFIT

Special Uses of Acetylene.—It may next be desirable to say a little on the special circumstances under which acetylene lighting is particularly satisfactory. Like the other systems with which we have been dealing, acetylene lighting is essentially a self-contained portable system, and mainly comes into use where electricity and gas are not available. It may indeed be said to fill positions very similar to those for which petrol air-gas is intended, so that the competition between these two systems of illumination is naturally somewhat keen.

In addition, acetylene may be said to represent all stages of portability, from the generator down to the tube filled with liquid acetylene. For instance, in France and Germany it is not uncommon for a small town, or even the

market place in a small town, to invest in an acetylene installation. In country railway stations again acetylene installations have been found to have a great field.

Like petrol-air lighting, acetylene also commends itself for the lighting of country residences. But here, again, the point should be emphasised that it is very essential to secure good workmanship. In the case of acetylene lighting it is particularly desirable that all piping should be properly laid and all joints absolutely gas-tight; consumers may be advised to have work of this kind undertaken by a specialist in acetylene lighting. It is far better to pay a little more and secure a reliable form of plant and sound piping, than to invest in a cheap installation which is a constant source of trouble and annoyance. Many reputable firms are willing to enter into an agreement to execute free any repairs which occur within a given period after installation, thus making themselves responsible for the plant being in good order.

There are, however, many other cases in which dissolved acetylene is particularly serviceable. For instance, when it was necessary to instal a generator on a railway train, the bulk taken up by the apparatus was a considerable disadvantage. More recently, however, liquid acetylene seems to have proved very convenient on quick trains. All that is necessary is to instal the cylinder and connect up to the pipe; at the end of a series of journeys, when the cylinder has been nearly exhausted, it is handed over to be re-charged and replaced by a new one. There are on record many instances of railway trains having maintained their lighting for many hours in an emergency. For instance, a train lighted by dissolved acetylene, which was blocked in a snowdrift in America, was once able to supply light without interruption for twelve days on end, and it is stated that in many of the carriages of the American Lackawanna Railway Company, cylinders only need re-charging every two months. Another field in which liquid acetylene might be expected to play a useful part is for omnibus and tramcar lighting, and I think that the importance and commercial advantage of lighting the inside of these vehicles in a reasonably satisfactory manner, demands the attention of omnibus companies. Again, liquid acetylene has been utilised for emergency lighting on festive occasions in churches.

Naturally acetylene obtained in this way must always be somewhat more expensive than when obtained from a generator, but this is compensated for by the convenience.

The coming of the incandescent mantle, however, has given new life to the application of systems of liquid gas to railway trains. At one time such systems were in danger of being ousted by liquid acetylene, and Professor Vivian Lewes introduced a system by which methane gas was mixed with acetylene, so that a compromise between the cheapness of the one and the high illumination obtainable from the latter was arrived at; this, however, was in the days of flat flame lighting. At the present day the arrival of inverted mantles capable of standing the vibration of trains has given to ordinary gas a powerful weapon, and the use of liquid gas in this way is not to be despised.

At the same time the introduction of the metallic filament lamps, which are particularly suited to the low voltages that can be employed on electrically lighted trains has proved a great help to electric lighting. One very real advantage possessed by such lamps is the fact that their installation would diminish the power output necessary from the generator, for a given illumination, by at least one-third.

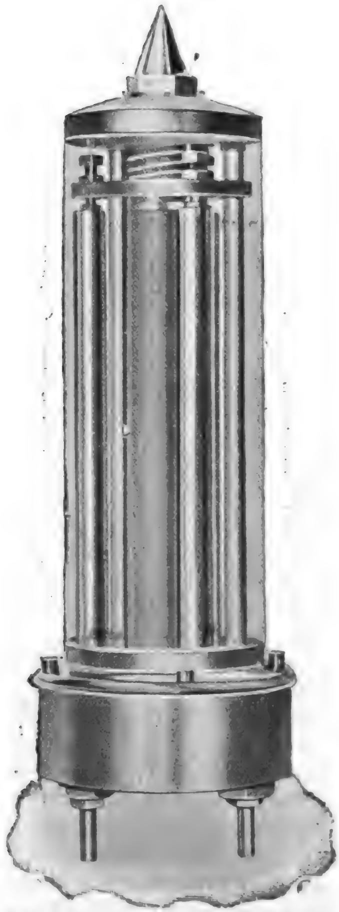
Acetylene Lighting of Buoys, Beacons, &c.—Lastly, I would like to refer to one field in which liquid acetylene has found a very extensive application indeed, namely, the lighting of buoys and beacons, &c., in inaccessible places. Those who are interested in this subject I should like to refer to a recent article in the *Illuminating Engineer* (Vol. I., 1908, p. 905).

Acetylene has been applied to lighthouses, and the lighthouse at Chassiron, one of the earliest to be illuminated by acetylene in France, now utilises an incandescent mantle illuminated by acetylene and credited with 105 candle-power per cubic foot.

But it is for small isolated buoys and beacons that acetylene has been found to be chiefly valuable, for a tube of liquid acetylene can be installed and replaced with great convenience. Canada has found such installations of very great value for buoys on her great rivers, and Sweden, whose maritime system of illumination is exceedingly important, has employed dissolved acetylene very extensively. By the kindness of the Acetylene Illuminating Company, Limited, I am able to show you a most ingenious automatic device for use with buoys of this character. The working of the apparatus is based upon the action of two surfaces, one of which is black and absorbs solar radia-

tion, while the other reflects it. This gives rise to a difference in temperature, and consequently an unequal expansion during the day which causes a valve to close and cut off the supply of acetylene, thereby effecting great economies. During the night, however, when the sun's rays are absent, the valve is open for the same reason that it closes during the daytime, and the apparatus is thus made completely automatic. Similar devices using the property of the selenium cell, the resistance of which is enormously diminished by the action of light, have also been employed.

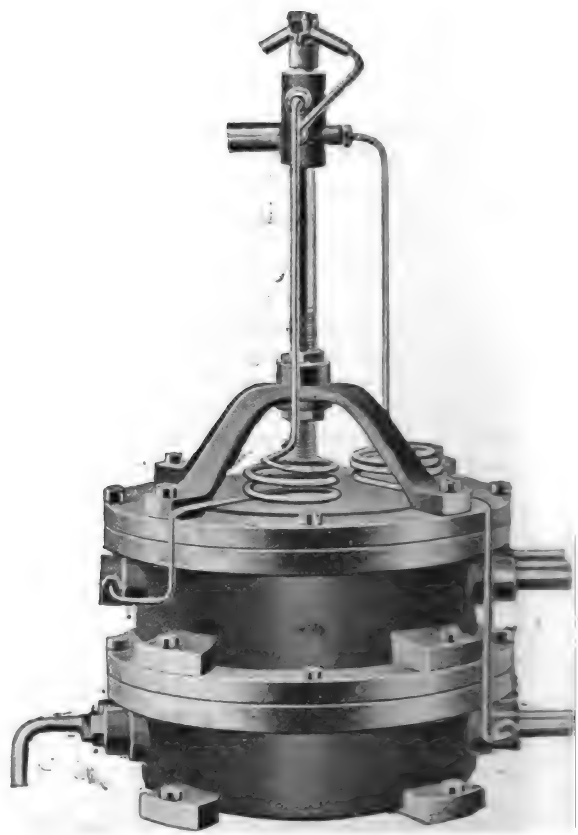
FIG. 63.



DALEN SOLAR VALVE, which automatically cuts off the main supply of Acetylene in Daylight.

Another ingenious automatic device manufactured by the same company—the Dalen apparatus, on exhibition to-night—is arranged to cut off all gas except a bye-pass, and then to re-admit the full flow of gas again at certain regulated intervals. In this way we obtain an automatic flashlight apparatus which is serviceable in two ways. In the first place the flashlight is more serviceable to attract attention in mists, &c., as a fluctuating light is more readily detected than a steady one. In addition it permits a great saving of gas to be accomplished. For instead of burning the light continuously it is now extinguished for certain definite intervals of time and only flashed occasionally. For instance, a flash of a duration of one-third of a second every

FIG. 64.



DALEN ACETYLENE FLASHLIGHT APPARATUS.

third second would lead to a saving of 90 %. The economy in gas over a long period may therefore be very considerable, and the use of this arrangement in conjunction with the solar valve referred to above, has been of great service in enabling buoys so equipped and placed in remote situations to be left unattended for much longer periods of time before a fresh charge of acetylene is needed.

Oxy-acetylene Welding and other Developments.—There are, of course, other important developments of acetylene lighting with which I cannot deal in any detail in

the space at my disposal, and which do not fall so strictly within my province in describing methods of illumination. I may, however, mention the use of the oxy-acetylene blow-pipe, which, in conjunction with a suitable incandescent material, is capable of producing a very powerful light, and is found very serviceable in connection with cinematograph displays, &c. Oxy-acetylene welding, again, is a very important recent development, which has been much assisted by the use of tubes of dissolved acetylene. The convenient simplicity of the apparatus utilising merely tubes of compressed oxygen and dissolved acetylene renders the process specially serviceable when no other source of power is available and in situations in which it is desired to carry the welding outfit from place to place. This, however, is an interesting subject which hardly falls within the scope of my present lecture.

The Costs of Various Illuminants.

Having now briefly described the chief modern systems of illumination, I may, perhaps, be expected to give some account of their relative costs. As I have explained before, I myself do not attach very much value to Tables of this description, partly because of the difficulty in ascertaining the exact conditions under which they were compiled, and also because the results, even if they are obtained on the same basis, will often prove to be misleading if applied to actual practical conditions. I have examined a series of Tables of this kind recently published: in some cases it was impossible to compare them with any precision owing to the different methods used in expressing the results.

I have, however, brought the costs down to the same basis, and compiled the following Table therefrom, which may perhaps be regarded as representative of average conditions :—

Cost of Gas, Oil, or Electric Energy only per 1,000 Candle-power.—Hours (Electricity 4d. per unit; Gas, 2s. 6d. per 1,000 cubic feet; Carbide, 3d. a lb.; Petrol, 1s. 2d. a gallon; Paraffin, 1s. 7d. a gallon).

	s.	d.
Electric flame arc	0	1
High pressure gas	0	1¼
Incandescent high pressure oil	0	1¼
Petrol air gas	0	1½ to 2
Electric mercury vapour lamps	0	2
Self-intensifying gas lamps	0	2¼
Incandescent mantle (low pressure)	0	3
Alcohol incandescent lamps	0	3
Electric open white arc lamps	0	3
Enclosed arc lamps	0	4
Helion electric glow lamps	0	4
Moore tube (electric)	0	4½
Tungsten electric glow lamp	0	5
Osmium electric glow lamp	0	6
Alternating arc lamp	0	6½
Argand gas burner	0	7
Tantalum electric glow lamp	0	7½
Miniature arc lamp	0	7½
Nernst electric glow lamp	0	7½
Metallised electric glow lamp	0	8½
Oil lamp	0	9
Flat-flame gas burner	0	11
Carbon filament electric glow lamp	1	2½

However, I consider that in reality, though such Tables are very useful (provided that the assumptions are clearly stated), as a means of comparing the efficiency of the source itself, they are certainly rarely reliable in any practical case where it is desirable to obtain a given value of *illumination*. For one thing, it is obviously absurd to compare a 1,000 candle-power unit with a small candle-power glow lamp; light for light the high candle-power source may be of a higher efficiency, but then we rarely wish to instal such a source in an interior of moderate dimensions; and in any case the diffusion of light would probably be so unsatisfactory from a single high candle-power source, that we should prefer a number of small sources, even if less efficient. Naturally too, there are very often many other conditions quite apart from cost which come into the problem.

For instance, the method in which the candle-power is specified in the case of different sources may vary considerably. Electrical sources are usually, but not invariably, expressed in terms of mean spherical candle-power, though mean hemi-spherical candle-power, or even horizontal candle-power is often used. In the case of gas lamps, however, it is customary to express the light from the lamp in terms of horizontal component in England, though in Germany the use of mean spherical candle-power is somewhat more usual.

These and many such like considerations do, I believe, usually render general comparisons of costs misleading when applied to practical conditions. When the assumptions made are clearly stated they have a certain value for reference, but any lighting engineer must necessarily consider each case on its merits.

PALO AMARILLO RUBBER.

The Palo Amarillo tree was discovered a few years ago on the slopes of the Sierra Madre, and upon investigation it was found to be a botanically unknown species. It is known in Mexico under a number of common names, such as palo amarillo, palo colorado, papelillo, and cucuracho, the first-mentioned name being generally used. It occurs in the dry semi-tropic zone on the slopes of Sierra Madre, at an elevation of 900 to 4,800 feet, generally being found above the oak zone, and frequently reaching as high as the pine zone of the mountains. It extends southwards from Durango to the southern part of Oaxaca, along the Pacific coast, growing on rather poor, rocky or sandy volcanic soil, and it often forms a part of the xerophytic plant formations that have established themselves on the dry mountain sides. The tree grows to a height of between twenty and thirty-four feet, with a trunk diameter of from seven to twelve inches. In the inner bark of the stem and its branches occur numerous latex-bearing vessels, containing a semi-liquid fluid of milky whiteness, which solidifies on contact with the air. Chemical examination of this latex shows that it contains from 7·3 to 15·7 per cent. of rubber, and from 19 per cent. upwards of resins. The United States Consul at the city of Mexico says that he has personally analysed seventeen latex samples from different parts of the tree, and from trees growing in different soils. The latex from the lower parts of the trunk contains the higher percentage of rubber, as is the case with all rubber-producing trees. The branches carry a latex containing mainly resins, the rubber being about 3 to 6 per cent., and occurring in a form which makes it very difficult to be separated from impurities. The coagulation of the latex is not easy, although it can be accomplished. The resulting rubber is of inferior quality and would commercially be classed with Guayule rubber, which, it is stated, has commanded a price of about one shilling and threepence, where the price of first-class wild Para rubber was three shillings and ninepence, per pound during the last year when rubber prices were low. It may be noted that rubber made according to modern methods from the ordinary Mexican rubber tree—*Castilla elastica*—has reached the highest standard of Para rubber and has realised the same price. The product of the palo amarillo tree being new, the test of time, which after all is the most important one, has not yet been applied, but taking into consideration the low tensile strength, the large percentage of resins, and the rapid deterioration of the latex through enzymes, it is not very likely that palo amarillo rubber will show a better result than the rubber obtained from the guayule shrub. The rubber is easy to vulcanise by the ordinary methods. The exploitation of the latex of palo amarillo is beset with considerable difficulties. The Consul states that he has tapped these trees in all the different manners generally employed in tapping Hevea, Manihot, Castilla, Funtumia, Ficus, or Sapium trees, and he has used over twenty of the different tools and implements, patented and employed in the rubber fields in Brazil, Central America and Africa, and he says that the proper method of tapping palo amarillo is not easy to determine. It is claimed that the palo amarillo tree is very easily propagated. A young branch cut from a growing tree and planted in the ground will grow. Commercially this does not mean much as the exploitable age of a palo amarillo tree must be at least ten or eleven years. A tree of this age does not give a very large amount of latex. The ordinary Mexican rubber tree, *Castilla elastica*, can be exploited when eight years old, and it then gives a larger yield of latex per annum than a ten year old palo amarillo tree. Considering that the latex of the former contains from 25 to 47 per cent. of pure rubber, against about eight per cent. in the palo amarillo latex, it is difficult to see the advantages of the latter under cultivation.

A TELE-VISION INSTRUMENT.

Writing in the August number of *Knowledge*, Dr. Alfred Gradenwitz gives a short but interesting account of an instrument just invented by Mr. Ernest Ruhmer, of Berlin, which is the first actual solution of the problem known by the barbarous compound, tele-vision. Dr. Gradenwitz had an opportunity of inspecting the machine before it was sent to Brussels for demonstration before the promoters of the Universal Exhibition which is to be held there next year, and of which a complete television apparatus, costing the sum of £250,000, will be the principal feature. The demonstration apparatus has been produced at a cost of £250, and owing to its more elementary construction only lends itself to the reproduction of simple patterns, consisting of squares arranged in different combinations. A projection apparatus throws the pattern on a screen hung up on the wall. The screen is a square divided into 25 square sections.

"Behind each of these sections," writes Dr. Gradenwitz, "is arranged a highly sensitive selenium cell in which, by a novel process, inertia has been absolutely eliminated. It thus responds instantaneously to any variation in lighting it is exposed to.

"At the receiving station is arranged a similar screen, divided into the same number of sections, each of which communicates with the corresponding section on the transmitting screen. While the actual system used in transmission is kept secret, this much may be stated, that a highly sensitive mirror galvanometer reconverts the fluctuations of current produced by fluctuations in luminous intensity on the transmitting screen into corresponding light variations. To the right of the receiving screen is seen the accumulator battery, supplying the current to the tele-vision circuits.

"As soon as a perforated pattern is inserted into the projector, a telegraphic reproduction of the picture is seen to appear at the very moment it is thrown on the transmitting screen. The sluggishness of the

cells has been compensated to such a degree that the telegraphic picture will respond practically instantaneously to any motion. In fact, a reproduction obtained at most in a few minutes with the photo-telegraphic apparatus so far constructed is here achieved in a fraction of a second, so that several phases of a motion can be reproduced within a second.

"It is hard to realise what sum of laborious work had to be expended in constructing even this relatively simple apparatus. In fact, each section, with its selenium cell and mirror galvanometer device, is an apparatus of precision in itself, while the definite apparatus will be composed of 10,000 elements of the same kind. Each selenium cell will have to be wound personally by the inventor, who never entrusts his work to anybody else."

WORLD'S TIME INDICATOR.

A UNIVERSAL TIME INDICATOR.

A clock, of entirely new design, and known as the "World's time indicator," has recently been made by Messrs. Kendal and Dent. Its principal object is to show at a glance the time all over the world. It consists of a clock movement, in front of which (in lieu of the customary hands) a disc is mounted which revolves with the earth once in 24 hours, having the hours 1 p.m. till 12 midnight, and 1 a.m. till 12 noon, painted on its outside edge, the hours being divided into intervals of five minutes each. In the same plane as the disc is a fixed plate or dial with a circular aperture to accommodate the disc. The dial has Greenwich painted on the top, the names of the other places being arranged at such distances from Greenwich that at any moment the corresponding time for any part of the world is shown. Greenwich being in the centre, the places which are situated in the east, and, consequently, are fast of Greenwich time, are painted on the right-hand half of the dial, the places west, and slow of Greenwich, being on the left-hand side. The clock can be set by turning the disc either from the front or from the back, so that if it is desired to ascertain the time at any place abroad at a given time in London, or other place, the disc can easily be set to give the information. The corresponding times for all other places will also be indicated on the dial.

The clock is at present on view in the hall of the Society's House where it may be seen by members until Wednesday, September 1st.

BELGIUM IN THE FAR EAST.

In recent years Belgium has displayed decided energy in the direction of the expansion of her already important trade in the Far East, and the relatively conspicuous position she now holds among the European nations, whose rivalry for commercial supremacy in that quarter of the globe is of the keenest, shows that her efforts have not been exerted in vain. The Belgian Government intends to participate in the International Exhibition which is to be held at Tokio, and will, it is asserted, use every endeavour to make Belgium's exhibit one of special prominence. The Government has also decided to install its diplomatic and consular officers in the East in more imposing quarters. A splendid new building for the Belgian Legation at Peking is now nearing completion, arrangements have been made at Shanghai for an imposing consulate-general, while at Tokio a similar building is to be erected. At Seoul, the Corean capital, a new residence has lately been built or the diplomatic representative of Belgium. These undertakings on the part of the Belgian Government

necessitate considerable increases in the annual budget, but such expenditure is looked upon by the commercial community in the country as an excellent investment for the nation. According to the American Consul at Liège, it is only since 1896 that Belgium has made serious efforts to enter the field of commercial activity in China. During that year the Belgian Minister at Peking notified his Government of the possibility of a Belgian firm being awarded the contract for building the Peking-Hankow railway line. The Belgian Minister of Foreign Affairs immediately called together a group of financiers and manufacturers of railway material to look into the question. This meeting resulted in the organisation of the Société d'Etudes de Chemin de Fer en Chine, that at once took the matter in hand. Important orders were given to Belgian firms for railway rolling stock and other material, and this proved to be Belgium's initial move in the expansion of her trade with the Far East. Prior to 1905 the efforts made by Belgians to foster closer commercial relations with China, being largely confined to the action of single individuals or firms acting independently, were not productive of results in keeping with the immense possiblities offered by the Chinese market, and at the same time were far from doing justice to Belgian commercial and industrial activity. The subsequent agitation in the commercial world, brought about by a full realisation of these conditions, led eventually to the organisation in Brussels of the Chinese-Belgian Chamber of Commerce, an institution having for its object, primarily, the grouping together of all interested industries, and assisting in every possible manner in developing and fostering their relations with the East. Supplying manufacturers and commercial bodies with information relative to the important markets of China, pointing out the kind of goods likely to meet with favour, and the prices for which such goods could be readily sold, emphasising the numerous opportunities for developing Oriental trade, encouraging a spirit of initiative on the part of Belgian industrial interests in taking advantage of these opportunities, supplying the Chinese merchants with information that would facilitate the exportation of their products to Belgium, and the purchasing in that country of goods that could find a ready sale in China, are among the leading aims of this Chinese-Belgian Chamber of Commerce, fostered through the intermediary of its official organ, entitled "Chine et Belge." This publication contains much useful information, and is expected to prepare the way for a vast army of Belgian manufacturers and merchants to form new trade relations. Another association, founded on similar lines, for fostering trade relations with Japan, is the Société d'Etudes Belgo-Japonaise. The special pains taken by Japan at the Liège Exhibition, in 1905, to make her section prominent, is considered as indicating a strong desire to enter into more intimate commercial relations with Belgium. The society has sent a representative to Japan. As a basis for his investigations, the society asks its members to indicate the special subjects in which they may be individually interested, so that a complete set of interrogatories may be submitted, such as will be of value in furthering the interests of increased trade with Japan. It is said that the information embodied in the replies to these inquiries will doubtless clearly illustrate a fact perhaps already well known in some quarters, that Belgian products are now extensively sold in Japan, but that, in most cases, such sales are made by other than Belgian houses, and that an extremely small percentage of such products finds its way into Japan by means of direct importation from Belgium. The work of the Société d'Etudes Belgo-Japonaise will include Formosa, Corea, and Manchuria. Owing to the success of the two organisations mentioned, others of similar scope have been recently formed, such as the Société Belgo-Russe, and the Société Belgo-Persane.

ARTS AND CRAFTS.

Design and Craftsmanship.—There is a feeling amongst competent trade designers, old and young, that design is in rather a bad way; that the public (or, at any rate, the middleman who caters for it) has at the present time no particular use for it, and next to no appreciation of what is good; that it feels, for the moment, very little interest in design at all. These men have watched the crafts taking little by little their rightful place among the lesser arts; they have been glad to see them getting their due, and some at least amongst them have helped to get them their due; but now they are beginning to feel as though the process had gone far enough, as though hand-work pure and simple were absorbing rather more than its proper share of public interest. It is not unnatural that, after many years of art teaching which failed to recognise the needs and the possibilities of artistic craftsmanship, the crafts, once come to life again, should want things all their own way; it is not surprising that an uneducated public opinion (and public opinion is not so rapidly educated as some folks seem to imagine) should seize upon the idea of craftsmanship with delight, and run the very word to death. Neither of these things need mean very much. Trade designers, like the rest of the world, look at things too much from their own point of view—and their judgment is not, therefore, to be trusted too implicitly. But, for all that, there are certain facts which have to be faced. Schools of art have in recent years been spending a large proportion of their energies on craft teaching. So far, so good. Craftsmanship is the foundation of applied art and it badly wanted attention. But applied art does not end there, and students have been rushing headlong upon craftsmanship only to find, too often, when their course was ended, that no one wanted their particular kind of craft work and that they could get no work to do. That is, after all, only the natural swing of the pendulum.

Art teaching which took no heed of craftsmanship has been avenged by a craftsmanship which makes little or no demand upon design. That is where the mischief has come in. It is because young people have so often been led to think that design is merely a subsidiary part of craftsmanship that so much modern craft work fails to satisfy those whose knowledge of things artistic is not wholly superficial. It is, perhaps, partly because designing upon paper has come to be spoken of rather scornfully and because the amateurs who flock to schools of art, and who ought to form the backbone of sound public opinion, have come to look upon it as a rather dull and unnecessarry subject, that the common demand for such things as wall-papers, carpets, tiles, printed and woven stuffs—for the things which cannot be produced in schools of art—is so tasteless and uneducated. Signs are by no means wanting that a saner and more reasonable view of the relative claims of design and workmanship is beginning to prevail. Designers may not see it—probably they would not be the first to recognise it—but there does seem to be a tendency both amongst teachers and students to realise more than they have done in the last few years the importance of a systematic study of design. Not until this feeling grows more general will public taste have a chance of improving. We flatter ourselves when we fancy it is always advancing.

National Competition.—If the exhibition of works to which prizes and commendations have been awarded in National Competition provides this year no very fresh or striking features, it proves on further study to be, on the whole, rather more interesting than usual. The greater part of the gold medals are given for book decorations of one kind and another or for figure compositions; but the steel presentation trowel from Leeds, with its leather case and damascened blade, has quite earned its award—and a very large proportion of the silver and bronze medals go to craft work or design. The show, on the whole, goes to prove that after a period of upheaval, things are beginning to settle down, and that in a very promising way. To begin with, a higher level of achievement seems to be demanded generally by the examiners. Of course, the standards of so many different men cannot be exactly the same, but it is much easier this year than it has often been before to guage the probable award made to any design without looking at the label. It seems to have taken the examiners as a body some years to learn to discriminate between the charm that is due to the quality of a material and that due to the invention of the artist, and to award prizes rigorously for design; but they show this year, both by their reports and their awards, that they are quite aware of the danger of being caught by effects which are none of the student's making, and determined to reward the candidate for what he has himself done rather than for merits which belong in great part to a material or a process of execution. It is, of course, rather difficult for an artist, whose natural inclination and training lead him to admire and delight in whatever is beautiful, to judge severely in this way; but it is quite obviously the right one, and the judges are to be congratulated on having arrived at it.

In the work exhibited there seems to be an improvement this year as regards both design and craftsmanship. There is nothing in the way of enamelling, jewellery, embroidery, cut-work, bookbinding, or illumination which commands attention; but there is a fair quantity of very capable work in all these sections and comparatively little of the crude sort of execution which might have passed muster a few years ago.

As regards design, too, the outlook seems very favourable. Not only are the flower studies for use in design very satisfactory, but the exercise known as "plant and three designs," in which the student has to send up the drawing of some plant with three different designs based upon it, is very much better done than usual this year; and that the "designs are this year," as the examiners point out, "more obviously founded upon the plant studies on which they are supposed to be based," is as it should be. There is evidence of far greater taste than heretofore in the colouring and general presentment of much of the illumination. As regards pattern design, too, things seem to be moving, however gently, in the right direction. There is not, so far, very much style about the work. It looks, indeed, as though very often the students were not quite sure what they themselves wanted to get, and had not knowledge enough of historic ornament to help them out of their difficulty, but the cocksureness of ignorance seems to be far less rampant than it was not so very many years ago. In short, the designs this year, if not very remarkable, are more modest, more restrained, more tasteful than they have been for some years past. The students who sent in some of the best work this year seem, if only they are teachable, to stand a chance of going further in the end than some of those who did more striking work two or three years ago.

Design at the Royal College of Art.—The show on the other side of Exhibition-road, of work done at the Royal College of Art is, from the point of view of art and craftsmanship, much less attractive. There are some very dainty little pieces of embroidery, and some interesting work in other crafts, but the exhibition as a whole is disappointing. After inspecting the work done in London in the schools aided by the London County Council and the output of the provincial schools as exhibited at National Competition, it is only natural to expect something rather better from the Royal College. The college stands in relation to schools of art generally, much as a university does to ordinary schools, and a proportion of its students at least consists of national scholars—the pick of the National Competition exhibitors of former years—and yet in looking at the design work and craft work

exhibited at the college, one is inclined to wonder how much of it would have taken a high award at National Competition. The standard is certainly not measurably higher, if we judge by results, than in the best of the London and provincial schools. Of course, it is somewhat of a shock for a provincial student to come up to London and be left to wander amongst the treasures of so great a collection as that housed at the Victoria and Albert Museum. And again, at the college there may not be the same inducement to do work which will look well in exhibition, as there is in schools where so much depends on this kind of success. But, when every allowance has been made, it would seem that the students at South Kensington might and ought to make a considerably better show than they have done.

NOTES ON BOOKS.

Bamboo for Paper-making. By R. W. Sindall, F.C.S. London: Marchant Singer, and Co. 2s.

Although bamboo has been recognised from very early times as a suitable material for hand-made papers, and has been utilised for this purpose for a great many centuries by the Chinese and other nations of the East, it is only in recent years that any serious attempts have been made to investigate the possibility of adapting it to the requirements of the modern paper mill. The first of such attempts was initiated by Mr. Thomas Routledge in 1870–75, and he published the results of his investigations in two pamphlets, "Bamboo considered as a Paper-making Material" and "Bamboo and its Treatment." Since that date a good deal of information has been published from time to time, and the present work is an attempt "to collect and classify the available data and to present the known facts in simple, condensed form, in order that the possibilities of an organised industry may be properly mastered." At a time when the demand for good paper pulp is becoming keener and keener every year, one cannot afford to disregard any material which may assist in averting a threatened famine, and Mr. Sindall's qualifications for his present task are vouched for by the fact that in 1905 the Government of India requested him to visit Burma to investigate the subject on the spot. The result of his enquiry was published in 1906 in a special report, "The Manufacture of Paper and Paper Pulp in Burma." The pamphlet contains interesting information on the growth and cultivation of the bamboo, the supply of material, the price of raw material, experimental plant, mill equipment, &c., which should prove of value to all those engaged in the paper trade. The work is printed on paper made from Burmese bamboo. The firm who converted it into paper regard the experiment as satisfactory in every way. The paper, they say, is strong, and possesses a surface calculated to be most useful for special kinds of printing, especially lithographic work.

The Engineering of Ordnance. By A. Trevor Dawson, Lieut., R.N., M.Inst.C.E., M.I.Mech.E., &c. London: Percival Marshall and Co. 2s. 6d.

The late Gustave Canet was an eminent artillery engineer, and it was fitting that the first Gustave Canet lecture, established in his memory at the Junior Institution of Engineers, should deal with such a subject as the engineering of ordnance. Lieutenant Trevor Dawson deals in an interesting fashion with many aspects of his theme. Beginning with a brief reference to "Mons Meg," the famous fifteenth century gun, which is still fired daily, at 1 p.m., at Edinburgh Castle, he passes on to describe the most up-to-date developments of modern ordnance, and discusses in succession the influence of metallurgy on guns, the influence of powders on the ballistics of guns, the influence of mechanics on ordnance, and, finally, the problem of the flying machine. The value of the lecture is enhanced by 68 plates, which are excellently reproduced.

GENERAL NOTES.

Imperial Arts League.—The Imperial Arts League has just been formed with the object of associating all members of the profession in every branch of the fine and applied arts, together with laymen interested in art matters, for the protection of artists, and for the advancement of the common interests of all concerned in the production, possession, or preservation of works of art. The organisation is officially supported by the Royal Society of British Artists, the Royal Institute of Painters in Water Colours, the Royal Institute of Oil Painters, the Royal British Colonial Society of Artists, the Ridley Art Club, the Society of Women Artists, and the Liverpool Academy of Arts. Among the members are Lord Balcarres, Sir H. von Herkomer, R.A., Sir E. J. Poynter, P.R.A., Mr. T. Brock, R.A., Mr. G. Clausen, R.A., the Hon. John Collier, Mr. Walter Crane, Mr. Frank Dicksee, R.A., and Mr. H. Thornycroft, R.A.

Atmospheric Nitrogen.—A review was recently given in *Stahl und Eisen* of the present position of the various processes for the recovery of nitrogen from the atmosphere. The whole question turns upon the possibility of obtaining the nitrogen by this means in a cheaper form than it can be bought in the natural compounds of this element already on the market. The only requirement for the artificial production is power at the lowest possible rate. The air contains 79 per cent. of nitrogen to 31 of oxygen. An account is also given of the electric processes for the production of calcium cyanamide by the plan proposed by Messrs. Caro and Frank of passing pure nitrogen over highly-heated calcium carbide. The Birkeland and Eyde systems, and those of Schönherr, Haber und Konig, are also discussed.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY

CANTOR LECTURES.

MODERN METHODS OF ARTIFICIAL ILLUMINATION.

By Leon Gaster, A.M.I.E.E.
(Editor of the *Illuminating Engineer.*)

PART V.*

INTRODUCTION.

In the previous lectures a very representative collection of different systems of illumination has been described, which may be said to offer almost a bewildering variety of choice to the consumer. I now wish to collect together some of the threads already taken up, and to say a few words upon the actual utilisation of the light available.

I have referred to the alteration in modern industrial conditions, our tendency to use more and more artificial light, and to continue to turn night into day; we now carry out our work in the night time with a facility undreamed of by our forefathers. At the same time we must feel that this very facility carries with it a degree of responsibility with which our forefathers perhaps were not troubled. At one time, before gas and electricity were available, there was no serious attempt to pursue our ordinary vocations by night. A few dim lights served to enable us to see about, but darkness was usually the signal for sleep; now, of course, all this is changed, and the present period, when developments in lighting are proceeding more rapidly than ever, is a fitting time to take stock of the situation.

Let us inquire, in the first instance, whether we are studying sufficiently closely how the light we are at such pains to produce should be actually applied? We may ask how much light is required for different purposes? What quality of light is desirable, what direction the light ought to come from, and how it should be distributed? All these are questions that now demand satisfactory answers.

We may indeed even go so far as to add one question more radical than any, whether, after all, we are doing wisely in proceeding on the course of turning "night into day"? We know how birds, for instance, are affected by climatic conditions. It has been an interesting experience at different zoological gardens in temperate climates to find that tropical birds do not thrive owing to the unequal periods of light and darkness interfering with their sleep. When artificial light was resorted to in order to reproduce the exact conditions of the tropics, the birds recovered their health and slept properly. The depressing effect upon miners of being obliged to work long hours in gloom and darkness is well known, and the melancholy nature of the night watchman's work is proverbial. In addition, it has been found that people who travel from one locality to another where the periods of light and darkness are very different suffer somewhat from this change, but they become acclimatised to the new conditions in time. Is it not, therefore, legitimate to inquire whether we ourselves may not experience certain effects due to physiological actions during the night time, which demand darkness, and whether our attempt to do away with a greater part of darkness might not be injurious to our health and sight?

DAYLIGHT ILLUMINATION.

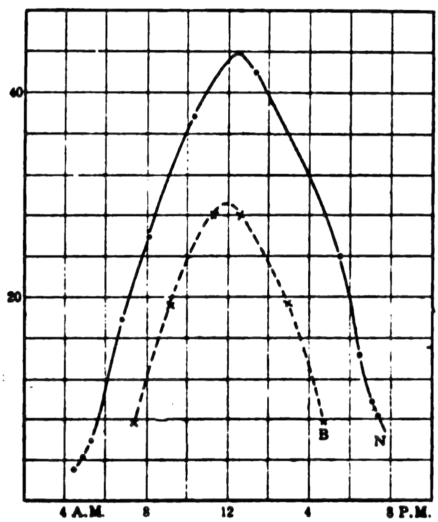
In all these perplexing questions, however, there is perhaps one guide on which we can rely even though we must not follow it too implicitly, namely, the qualities of natural daylight, to the best use of which our eyes have been gradually developed through countless generations. It is, therefore, desirable to say something regarding illumination of this kind, for our acquaintance with daylight conditions naturally modifies our impression of artificial methods of lighting. Yet here again, we must remember that daylight itself must be

* The Course consisted of four lectures, delivered on February 15th and 22nd, and March 1st and 8th. In re-arranging the material for publication in the *Journal*, the lecturer has preferred to divide it into six parts.

studied scientifically in order to use it to the best advantage. Both its quality and its intensity differ very greatly at places at different seasons, and at different times of the day. Weber in Germany, and Basquin, Nichols, and others in the United States have studied this question closely.

Some idea of the manner in which the illumination in a room may alter during the day, and at different periods of the year, will be understood from Figs. 65 and 66, which are taken from a paper by Dr. E. L. Nichols before the Illuminating Engineering Society in the United States in 1908. We must not be too ready to assume that because daylight is the natural method of illumination, therefore it can take care of itself and does not need proper attention.

FIG. 65.



Time of Day.

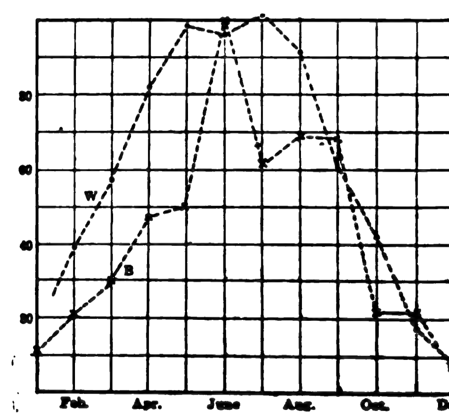
VARIATION IN INTENSITY OF DAYLIGHT DURING THE DAY.

N. Nichols (Tyrol).
B. Basquin (Chicago).

Naturally, provision must be made to secure that such illumination of buildings is sufficient to enable people to carry out their work with comfort. Indeed, it will be found that the actual intensity of illumination at different parts of a room lighted by daylight varies even to a greater extent that when illuminated by artificial light, according to the nature of the windows. In an office in Victoria-street with which I am acquainted, for example, a recent test showed that the intensity of illumination just inside the window at 10.45 a.m. was as much as 50 foot candles, whereas on a desk only 12 feet away from the window it was less than 1 foot candle. The matter of the careful study of daylight illumination in schoolrooms, on which I mean to touch on later, can hardly be over-estimated. When we consider how much work is carried out during the day time, we can see how important the study of the necessary conditions really is.

In passing, it might be of interest to mention that Mr. P. J. Waldram has recently been studying the measurement of daylight illumination from the architect's standpoint, and has found actual measurements of very great value in supporting the contentions in connection with cases of ancient lights in court. This is an instance of the unexpected directions in which the value of the measurement of illumination often comes to be felt.

FIG. 66.



Month of Year.

VARIATION IN INTENSITY OF DAYLIGHT DURING THE YEAR.

B. Basquin (Chicago).
W. Weber (Kiel).

I may also refer to the various efforts that have been made to specify the amount of a window space, &c., in schools and factories, and to pre-determine what the actual illumination is likely to be. For instance, in addition to Mr. Waldram's experiments (*Illuminating Engineer*, Vol. I., pp. 241, 811), Prof. Ruzicka has attempted to prepare a small artificial model of the room under consideration, illuminated by an artificial sky (*Illuminating Engineer*, Vol. I., p. 539).

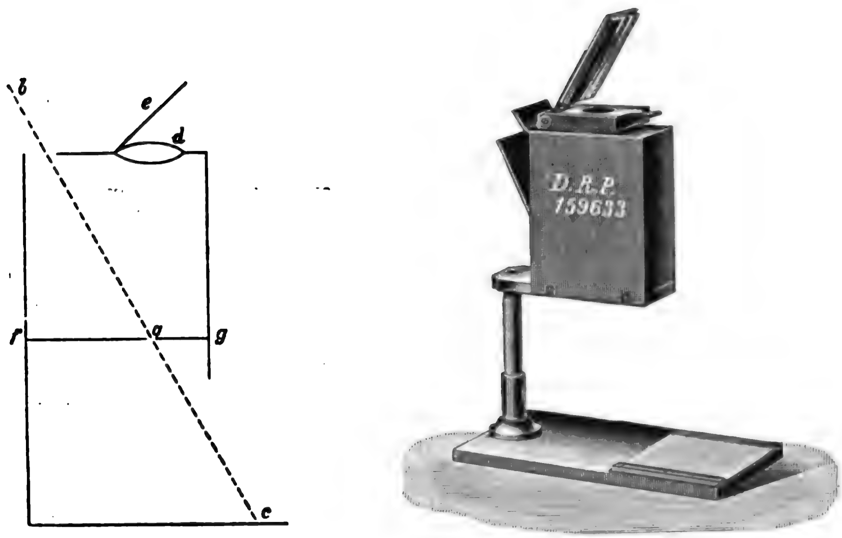
Naturally such a method of pre-determining the conditions of lighting in a building yet to be erected, might be of considerable value, for

it is not always easy for the architect to estimate beforehand whether the access of daylight to long corridors, or even rooms, is adequate.

Since the date of the lectures, Mr. Waldram has published some further results of the application of the above method of testing the daylight illumination to interiors. He has explained that under all ordinary conditions, a constant relation can be shown to exist between the intensity of illumination at a certain point in a room, and the unrestricted illumination out of doors. The value of this constant will, of course, depend upon many factors, upon the nature of the window space, the height of the houses opposite, and the reflecting power of the wallpapers used in a room, for example. But for a given room it will have the same value from day to day under widely different climatic conditions, and will, therefore, constitute a rough index as to whether the provision of daylight-access to a room is to be considered satisfactory or no. Of course it may happen that a room for which this constant is regarded as unduly low may nevertheless be sufficiently illuminated for a part of the day. But as seen above, this is not sufficient; we must prescribe conditions which render it highly improbable for the light ever to fall below the requisite minimum

Mr. Waldram considers that an office which enjoys 0·001 of the outside illumination at the centre of the room might be regarded as fairly satisfactorily illuminated, though, in the case of school children this figure might be deemed too low. In the article in question he quotes a series of figures for different buildings in London of which the following are a few examples :—

Fig. 67.



Thorner Illumination-Tester.

Proportion of Unrestricted Outside Illumination received by Interiors of Buildings.

New suburban elementary schools (children's desks)	0·0025 to 0·008.
New urban technical schools, ground floor average	0·001.
Ordinary offices, average at centre of room	0·001.
British Museum reading-room	0·007.
Royal Courts of Justice, Judges, seats	0·0007 to 0·0022.
House of Commons—	
Clerk's table	0·0008.
Speaker's chair	0·0009.
Members' seats	0·0003 to 0·0007.
House of Lords—	
Woolsack	0·0004.
Members' seats	0·004 to 0·0006.
Charing-cross Station Booking-hall	0·0001 to 0·0003.

Another simple form of apparatus for studying daylight-condition is that due to Thorner which is on exhibition to-night. This arrangement is shown in Fig. 67. The instrument is based on the same principle as that indicated by previous remarks, serving virtually to com-

pare the brightness of the sky at any moment (which is a criterion as to the outside unrestricted illumination), with the actual illumination in the room. By means of the lens, *d*, an image of the sky, reflected by means of the adjustable mirror, *e*, is formed at the paper, *fg*, in which there is a pinhole at *q*. The observer looking along the line, *bqc*, sees the white surface behind this pinhole at *c* and superimposed on this the image of the sky at *q*. Now the surface at *c* is illuminated by the available light in the room just as a book might be. If this illumination is too weak, the spot *q* appears black on a white surface; if, however, the illumination at *c* is to be judged satisfactory the contrary is the case. If the spot seems to be just equal in shade to the image of the sky the conditions are just on the border-line between what is to be considered adequate and what is not. It may be said that in many rooms no sky is visible and therefore the instrument cannot be applied, but it seems to be suggested that this in itself would lead one to consider the daylight conditions unsatisfactory.

The Reflecting Power of Wallpapers, &c.

While mentioning this matter reference may be made to the importance of bearing in mind the reflecting powers of the walls and furniture in a room and the great influence which such surroundings exert upon the available illumination. In any interior the effective illumination on a book or table consists only partially of the direct rays from the source of light. In addition, valuable assistance is rendered by the light reflected from surroundings. It is also preferable, physiologically, to avoid the extreme contrasts of very dark walls and gloomy surroundings, and the relatively bright surface of the book we are reading, or the paper on which we are writing. With this point we shall deal again in subsequently discussing inverted systems of lighting.

The general nature of the reflecting power of different surfaces will be gathered from the Table (p. 847) which has been compiled and presented before the Illuminating Engineering Society by Dr. Louis Bell.

The reflecting power of surroundings is naturally a matter which ought to be borne in mind by decorators and architects when advising as regards the furnishing and decoration of an interior. In such cases it is certainly to be desired that the architect, in whose hands the treatment of the æsthetic side of the problem mainly rests, and the engineer, who is concerned with the practical lighting arrangements, should work hand in hand. In the case of buildings of a more or less utilitarian character it may be recommended that the walls of the room should be in general light in shade but tinted and not pure white.

Before leaving this question it may also be pointed out that not only the quantity but the *quality* of light is affected by the surroundings. Thus in a room with red wallpapers the amount of reflected light usually suffices to give the illumination a distinctly reddish tinge, and this, of course, is not without effect on the appearance of coloured objects brought into the room. In the same way the colour of the surroundings must, to some extent, govern the colour of the illuminant which it is preferable to select. For instance, it would clearly lead to a certain loss of light and might be undesirable æsthetically to employ a source which was deficient in red rays and rich in green in a room in which the prevailing tint was red.

Intrinsic Brilliancy.

Turning now to artificial illuminants, I come to speak of one very important respect in which artificial illumination of the present day differs from daylight, namely, in intrinsic brilliancy. We have gradually become accustomed to the use of concentrated sources of light far brighter than the brightness of the normal sky. For instance, Dr. Stockhausen has given the following figures for different illuminants :—

Intrinsic Brilliancy of Various Illuminants (Stockhausen, Zeit f. Beleuchtungswesen, Oct. 10th, 1907).

Source.	Intrinsic brilliancy (c.p. per sq. in. of radiating surface, approx.).
Petroleum lamp	20
Incandescent mantle	35
Carbon filament glow-lamp ..	540
Metallic " " ..	1,100
Nernst " " ..	2,250
Arc light (Crater)	17,000

Average Intrinsic Brilliancy of Sky (Basquin).

3·5 candle-power per sq. in.

Minimum Intrinsic Brilliancy Recommended.

Stockhausen	4·2 c.p. per sq. in.
Woodwell (Ill. Eng. Soc., 1908)	0·1 " " "

Some other interesting figures on the same subject have just been published by Professor Barrows in his book on "Electrical Illu-

TABLE OF COEFFICIENTS OF DIFFUSE REFLECTION (Dr. Louis Bell).

Kind.	Colour.	Coefficients for Skylight.	Incandescent Lamps.	Remarks.
Plain ceiling.. ..	Faint greenish	·50	·53	—
,, ,, ...	Light ecru	·27	·26	—
,, ,, ...	Very faint grey cream	·53	·64	—
,, ,, ...	Light grey cream	·26	·23	—
,, ,, ...	Light yellow	·53	·49	—
,, ,, ...	Faint ecru	·47	·55	—
,, ,, ...	Faint pinkish	·41	·43	—
,, ,, ...	Pale bluish-white	·42	·31	—
Crêpe	Medium green	·25	·19	—
,, ...	Darkish coffee brown	·08	·06	—
,, ...	Deep green..	·05	·06	—
,, ...	Deep yellow buff	·41	·41	—
,, ...	Full green	·06	·06	—
,, ...	Deep red	·05	·05	—
,, ...	Medium red	·06	·01	—
Cartridge	Medium green	·15	·11	—
,, ...	Dull green	·11	·07	—
,, ...	Dull yellowish-green..	·09	·07	—
,, ...	Light pinkish-brown	·21	·26	—
,, ...	Light green	·23	·18	—
,, ...	Light blue	·21	·30	—
,, ...	Pale grey	·35	·27	—
,, ...	Faint yellowish green grey ..	·43	·33	—
,, ...	Salmon buff	·31	·33	—
,, ...	Medium light buff	·44	·44	—
,, ...	Medium full green	·11	·07	—
,, ...	Medium dull red	·06	·07	Grey red
,, ...	Light red	·10	·10	—
,, ...	Very deep ecru	·18	·15	—
,, ...	Pale pink	·25	·19	—
,, ...	Deep yellow grey	·18	·15	—
Silky finish	Medium crimson	·08	·12	Across grain
,, ,, ...	Medium grey green	·17	·12	—
Stripes	Deep cream	·56	·60	—
,, ...	Deep cream silvery	·56	·57	—
,, ...	Yellow medium..	·50	·53	—
,, ...	Deep buff	·53	·58	—
,, ...	Medium red	·06	·08	—
,, ...	Medium red satin	·07	·11	—
,, ...	Light strawberry pink	·43	·43	—
,, ...	Light strawberry silvery	·51	·49	—
,, ...	Light and dark green	·06	·07	Heavily streaked deep green
,, ...	Silvery light	·13	·14	—
,, ...	Light green	·36	·26	Plain
,, ...	Silvery light green	·36	·23	Corded
Miscellaneous ..	Dark green and gold	·24	·19	Minute figuring with much gold
,, ..	Light green and gold	·31	·28	—
,, ..	Deep and light red	·12	·20	—
Piqué	Light bluish	·46	·47	—
,, ...	Light grey	·38	·38	—

minating Engineering": these are given in the following Table:—

THE INTRINSIC BRILLIANCY OF VARIOUS ILLUMINANTS. (W. E. Barrows, *Electrical Illuminating Engineering*.)

Nature of Source.	Candle-power per sq. inch.
The Moor Tube	0·6
Frosted incandescent lamp	2-5
Candle flame	3·4
Gas flame	3-8
Oil lamp	3-5
Kerosene lamp	4-8
Cooper Hewitt lamp	16·7
Welsbach gas mantle	20-25
Acetylene flame	75-100
Enclosed a.c. arc depending on globe	75-200
Enclosed d.c. arc depending on globe	100-500
Incandescent lamp 4 watts per candle	300
Incandescent lamp 3·5 watts per candle	275
Incandescent lamp 3·1 watts per candle	480
Gem lamp 2·5 watts per candle	625
Tantalum lamp 2 watts per candle	750
Nernst lamp (bare)	800-1000
Tungsten lamp 1·25 watts per candle	1000
Sun on the horizon	2000
Flaming arc	5000
Open arc lamp	11000-50000
Open arc crater	200000
Sun 30° above the horizon	500000
Sun at zenith	600000

After each fresh departure in our methods of illumination, it invariably takes some time for people to get accustomed to the new conditions. It is interesting to recall the comments of the great chemist, Clement Desormes (see Cantor lecture by Professor W. Grylls Adams, F.R.S., 1881), who in 1819, when the gas light was first introduced, said:—

"The light is of a disagreeable yellow colour, entirely different from that red and warm gleam of oil lamps; it is of a dazzling brightness; its distribution will be impossible and irregular, and it will be much dearer than oil lighting; and, even if it should be improved, it will still remain much dearer than those lights which we already possess."

To-day, when we are accustomed to sources so much brighter than the flat flame gas burner this comment may seem amusing. But let us pause a little. It is in fact now realised by those who have studied illumination that this quality of intense intrinsic brilliancy is one of the seriously inconvenient qualities of modern sources of illumination. Most of you will at once concede how unpleasant is the dazzling effect of looking straight at an arc lamp, high pressure gaslight, or a naked metallic filament glow lamp at close quarters. You will find that after looking steadily at such a source for a few minutes, and then shutting the eyes, a distinct "after-image" is perceptible, which may appear to fade away in a few minutes, or even seconds, but which certainly corresponds to some abnormal, and therefore possibly injurious effect on the state of the eye.

In order to illustrate this point an analogy may be drawn with the action of a photographic plate. When a photographic plate receives a luminous image upon it, it is immediately affected and retains the image owing to a chemical change in its constituents. This only reveals itself when the plate is subsequently developed. But the plate can be kept undeveloped for some time, and though apparently unaffected as far as appearance goes the image is still there. Yet some observers have stated that, provided the plate is kept long enough, the image weakens with time, and has been known to fade away at last; the plate therefore seems to resemble the eye in recovering from severe exposure very gradually. This interesting analogy might well be made the subject of further study.

But on the other hand we know that an underexposed plate reveals but a faint image, and if the stimulus be sufficiently weak no perceptible image is retained at all. In the same way the eye, when exposed to a severe luminous impression, tends to retain the image afterwards and fails to recover immediately its normal condition; but an image which is not unduly bright passes away and leaves no apparent traces.

It might be mentioned that a very severe exposure indeed may produce local disturbances in vision which persist for a very long time; for instance, Prof. G. J. Burch has recorded inconveniences of this kind in his own case as the result of incautiously experimenting in connection with this very subject. In addition he has found that when we are removed into a completely dark room, these "after-images" on the eye sometimes seem to be still traceable after a couple of hours of complete rest.

We may also compare what happens when a photographic plate is exposed to a very bright object such as, for example, the windows in a somewhat subdued interior. Under these conditions we know that the image of the bright object is not sharply defined. There is "halation," and the outlines of the bright surface are surrounded by a misty halo owing to the spreading of the chemical effect beyond the proper limits. Even so our vision seems to

be impaired when gazing at bright objects. The filament of an incandescent electric lamp, for example, appears much thicker to the eye when incandescent than when in the unheated state.

Bearing in mind the order of brightness of the sky, which Prof. Basquin, as the results of experiments in the United States, extended over a long period, has estimated to be on the average in the neighbourhood of 3·5 candle-power per square inch, some authorities have recommended that the intrinsic brilliancy of sources of light liable to fall in the direct field of vision, should not exceed 5 candle-power per square inch. More recently, however, it has been felt that even this value was excessive in the cases of sources comparatively near to the eye, and Drs. Schanz and Stockhausen and also Mr. J. E. Woodwell (Paper read at the Annual Convention of the Illuminating Engineering Society, United States, 1908; *Illuminating Engineer*, Vol. I., p. 80) have recommended a value of the order of not more than 0·4 to 0·2 candle-power per square inch.

Before leaving this subject I should like to refer to the manner in which my previous comments on the subject of intrinsic brilliancy have been misconstrued, and in some cases, I fear, deliberately distorted. I urged, and with justice, when reading a paper before the meeting of the British Association at Leicester in 1907, that the new electric metallic filament lamps would undoubtedly have an injurious effect on the eyes if placed in the direct line of sight. In other words, this new source must be properly used and not abused. Unfortunately the gas interest in one of their publications utilised my warning without also mentioning in detail the circumstances under which it applied, thus giving the impression that I was responsible for the statement that the electric light was injurious to eyesight. I take this opportunity of pointing out that modern incandescent gas-lights used under the same faulty conditions, in the same careless manner, would also be objectionable.

I do not, however, wish to dwell on this aspect in any alarmist manner, but only to point out that this defect must be faced, and probably can be met by comparatively simple precautions. The obvious moral is that such bright sources ought to be kept out of the field of view of the observer, or if visible, their brilliancy ought to be suitably reduced by the effective use of shades. Apart from the possibility of physiological injury, common sense tells us how absurd it is to try to see any object with a bright source in between this object and the eye. If we are in a brightly lighted room our eyes adjust themselves to the brightness within but are incapable of seeing anything outside in the darkness; on the other hand, a person out in the dark can see into a lighted room without being seen himself. This fact ought to be borne in mind by the shopkeeper who deliberately places bright sources of light in front of his goods in his window; as a natural result the pupil orifice of the eye and the retina adjust themselves to this bright object and those objects which are only illuminated by a moderate intensity cannot be seen. In this connection I should like to speak with approval of the recent action of the City authorities in specifying that such bright sources should be screened in the direction facing the street, so as to avoid their tendency to dazzle the drivers and pedestrians. I may quote an effective motto recently put forward in one of the Holophane Illumination publications, "*Light on the object, not in the eye.*"

We may, in fact, regard it as an axiom that any source of light itself must be regarded as the crude product until it is effectively screened with a suitable diffusing shade; in America it has now become customary to supply "units" which consist of a source, perhaps an incandescent glow lamp equipped with a suitable reflector or globe, and seldom used without this combination. Indeed, so serious is the effect on the eyes of brilliant unscreened sources in the direct range of vision now felt to be, that I would almost consider the time ripe for definite governmental recommendations that such sources must invariably be provided with a suitable diffusing screen or shade, which will adequately protect the eyes.

There is really nothing very revolutionary in proposing recommendations of this description on such a vital point. But a few years ago, the importance of such questions as ventilation and purity of air was hardly generally realised, and those who insisted upon the need for supervision of these conditions in factories, were looked upon as extremists. At the present time, the importance of pure air, through gradual and persistent effort, has come to be so generally appreciated that factory inspectors are in a position to make strong recommendations on the subject, and even to prosecute when the conditions are clearly unjustifiable. And as interest in the subject has increased, so have methods of testing become more precise. At

the present day, valuable evidence can be obtained from the chemical analysis of samples of air in buildings, which are enclosed in small bottles, taken away by the inspector, and forwarded for examination to a central laboratory. Similar progress may be looked for in connection with illumination.

Another illustration of the result of convictions on hygienic matters gradually born home is the recent determined attempt to eradicate the objectionable habit of spitting. Once it came to be generally appreciated how vital was the importance of restricting this source of propagation of tuberculous disease the restriction met with little opposition. But what an outcry such a suggestion, interfering with the license previously enjoyed, would have raised a few years ago!

In the same way it may be suggested that a few wholesome regulations regarding obviously desirable improvements in existing methods of using light will soon be regarded as perfectly natural. It is quite as important to eradicate a foolish and unreasonable practice which is bad for the eyes, as it is to take due measures for the preservation of public health in other respects.

It may, therefore, next be of interest to discuss briefly a few of the methods of reducing the intrinsic brilliancy of illuminants by suitable shading.

Most of you are familiar with the use of the opalescent and opal glass for this purpose, and may know too that frosted glass has been very frequently utilised, especially in connection with electric lamp bulbs. In addition, in our drawing-rooms we frequently have recourse to silk shades in order to tone down the brightness of portable lamps distributed about the room.

Such methods may, of course, serve the purpose of producing a suitable diffusing surface; unfortunately, in so doing it is difficult to secure really adequate diffusion without at the same time losing an enormous amount of light.

I may mention, for instance, some data relating to the absorption of different types, which have been published by Professor J. T. Morris, Dr. B. Monasch, and Professor Barrows.

The Absorption of Various Globes (W. E. Barrows, *Electrical Illuminating Engineering*).

			per cent.
Clear glass	globes absorb	from	5-12
Light sand blast	,,	,,	10-20
Alabaster	,,	,,	10-20
Canary coloured	,,	,,	15-20
Light blue alabaster	globes absorb	from	15-25
Heavy blue alabaster	,,	,,	15-30
Ribbed glass	,,	,,	15-30
Opaline glass	,,	,,	15-40
Ground glass	,,	,,	20-30
Medium opalescent	,,	,,	25-40
Heavy	,,	,,	30-60
Flame glass	,,	,,	30-60
Signal green	,,	,,	80-90
Ruby glass	,,	,,	85-90
Cobalt blue	,,	,,	90-95

(*Professor J. T. Morris*).

			per cent.
Clear glass	globes absorb	from	14·8
Slightly opalescent	,,	,,	23·8
Small opal	,,	,,	17·2
Large opal	,,	,,	21·7

(*Dr. B. Monasch, Elektrische Beleuchtung*).

			per cent.
Clear glass	globes absorb	from	9·2
Opal	,,	,,	17·1
Alabaster	,,	,,	33·8

In addition, such methods only serve the purpose of reducing brightness; they are not effective in directing the light where required, or concentrating it on any particular spot.

These considerations have led to the introduction of a type of scientific glassware, of which we have some notable examples on exhibition. Cut glass has for a long time been utilised for the purpose of diffusing light sources. In the cut glass globes used until recently, however, such grooves as were made in the glass were only made quite haphazard, with the result that although a certain amount of diffusion was obtained, there was no attempt at direction, and the amount of light through any such globe having no appreciable diffusing power was very small indeed.

About 25 years ago, however, some experiments were carried out by Mr. A. P. Trotter in this country, and M. Blondel and subsequently by M. Psaroudaki in Paris, with the object of making scientific prismatic glassware which should not only absorb a minimum amount of light, but should diffuse it and also distribute it in any desired direction in a scientific manner. At that time the inventors may be said to have been far ahead of their age, and, therefore, we once more meet with an instance of early pioneering work in this country which has subsequently led to successful developments in illumination. For some years past the Holophane Company in the United States have taken up the question with great energy, and are manufacturing

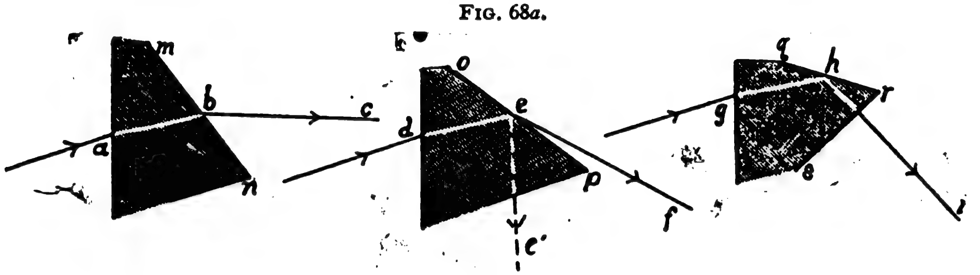
many models of fixtures of this kind for use with gas, electricity, or any other illuminant that may be desired, and designed specially with the object of utilising the light scientifically.

In this connection I might quote the action of the Franklin Institute in Pennsylvania, who in 1897 awarded the John Scott Legacy medal and premium to Messrs. Blondel and Psaroudaki, for their invention of a globe which secured much better diffusion and more satisfactory distribution than any other globe known to its members.

than was permitted by the simple prism arrangement.

When it is desired to distribute the light in a room, the individual rays from the source pass through the prismatic ribs and are reflected and refracted in a scientific and uniform manner so that each spot on the surface of the enclosing globe virtually becomes a new distributing centre; thus the light coming from the source is spread over an extensive surface, and the glare of the concentrated source is replaced by an apparently uniformly illuminated globe.

FIG. 68a.

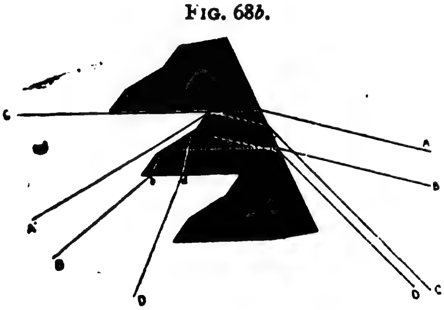


Refraction. Refraction and Reflection. Total Reflection.

The general nature of the prisms of which this scientific glassware is composed will be understood from Figs. 68a and 68b.

Fig. 68a shows the course of the rays through the simpler form of prism employed by the older inventors. It will be observed how the rays are bent out in different directions according to the inclination, and it will

FIG. 68b.



also be readily understood how, in utilising Holophane glass, it is essential to employ only a globe or reflector intended for use with the lamp for which it is specially designed. In Fig. 68b will be seen the more complete prismatic arrangement adapted by M. Blondel and M. Psaroudaki, which enabled the light to be spread over a wider angle and distributed more perfectly in the desired directions

In addition, this naturally serves to distribute the light effectually in all directions and to remove that "streaky" appearance, which is the result of the lack of uniformity in the distribution of light from most naked sources. The use of a shade of this kind also gives rise to a "soft" light; that is to say, there are no unduly sharp shadows. For instance, if the Holophane globe is removed and the lamp hangs naked below the metal holder the result is a dark shadow on the ceiling which appears irregularly illuminated; this, however, gives way to apparent uniformity and absence of shadow when the Holophane globe is replaced.

In many cases, what we chiefly desire is to distribute the light evenly in all directions, and Holophane globes may be designed with this object. In other cases, however, we desire the greater portion of the light to be reflected at a certain angle, in a downward or upward direction, and this, by a slight modification in the shape of the crystals, can also be done.

A number of examples of diffusing and concentrating Holophane globes and reflectors are on exhibition to-night. (Figs. 69, 70, 71, 72.) The glass reflectors are perhaps of special interest, because they are so designed that while concentrating the great bulk of the light in a downward direction where it is wanted, they also allow a small amount to pass in an

upward direction; therefore we may mount a a suitable silk shade over such a reflector and we shall have the advantages of efficient reflec-

FIG. 69.

HOLOPHANE CLUSTER.

FIG. 70.

HOLOPHANE REFLECTORS ENCIRCLING LAMPS WITH FROSTED TIPS.

tion, and yet enough light coming upwards to make the shade appear ornamental. Metal reflectors do serve the purpose of concentrating the light, but, of course, have not the above-mentioned property.

Glass ware of the Holophane type can be applied with success to all the various methods of illumination, gas, oil, electric light, &c., and new designs are constantly brought out to suit the different types of lamps as they come upon the market. One feature of special importance, as mentioned previously, is the supply of a given lamp, with its appropriate shade, as a single unit. In this way the most efficient results are secured to the consumer who is taught to consider any lamp incomplete unless

FIG. 71.

HOLOPHANE DIFFUSING GLOBE.

it is properly shaded. I have dwelt on this matter in some detail because during my recent visit to the United States, where scientific illuminating engineering has received so much attention, I found that this scientific glass was very widely used.

INDIRECT LIGHTING.

While speaking of methods of diffusing light mention may be made of the inverted system of lighting by means of which all the direct rays of a source are thrown on the ceiling, and the eye therefore receives no direct rays and an approximately shadowless illumination can be obtained. Formerly this method was

used in connection with arc lights and high-pressure incandescent gas lights, but the coming of the high candle-power efficient metallic filament glow lamp may lead to its more general adoption than hitherto. Figs. 74 and 75 show some examples of this method, recently described in a paper before the Illuminating Engineering Society of New York.

respect when the walls of the rooms were very light in texture. If the book we are reading is somewhat brighter than the surroundings, however, our attention is involuntarily rivetted on the page, and when our eye does stray away it is rested by the more subdued tone of the surfaces on which it plays. On the other hand, it is pointed out, when there is light everywhere the eye gets no such rest.

Fig. 72.

Holophane Globes in Position Illuminating a Verandah.

At one time the production of an entirely shadowless illumination was held to be very desirable, as it corresponded with a close resemblance to daylight conditions. More recently, however, illuminating engineers have come to feel that an intermediate condition of things is desirable. We do not want very sharp contrasts of light and shade, which are admittedly trying to the eye, but, on the other hand, artistic and even utilitarian requirements rarely favour entire lack of shadow.

It had been suggested, for instance, that, when reading a book, we do not desire the surroundings to be too bright in comparison, for this tends to distract attention. It has recently been found in New York that indirect systems were sometimes inconvenient in this

But we must certainly avoid going to the other extreme. Dr. Louis Bell, for instance ("The Physiological Basis of Illumination," Proc. Am. Academy of Arts, 1907) has pointed out that it is very undesirable for a desk to be brilliantly illuminated while the surroundings are in complete obscurity. Under these conditions the eye is not rested when it strays from the book, but receives a positive shock owingto the change in the conditions. Each time it turns away, the pupil-aperture and the retina attempt to accommodate themselves to the darkness, and, having done so, are called upon to reverse the process once more, when attention is again bestowed on the brightly-illuminated book on the desk.

Fig. 76, which is taken from the communication of Dr. Bell to which reference has just been made, is presented as a bad example of extreme contrast in this respect.

As an illustration of an attempt to secure more uniform conditions for desk lighting, we may take Fig. 77, which shows a desk illuminated by the diffused illumination from a Regina arc lamp hung high up. Probably it will eventually be recognised that the wisest course in this matter is an intermediate one. Thus we shall feel it advisable to secure a fairly low, subdued general illumination—such as may conveniently be produced by an indirect method of lighting—and to superimpose a stronger local illumination at the desk or table where we wish to work, and on which we wish to concentrate our attention. It will be seen, therefore, that it must not be too readily assumed that inverted lighting pure and simple, which some people have supposed to be the closest equivalent to daylight condi-

FIG. 73.

ILLUMINATION OF MANCHESTER INFIRMARY CHAPEL BY INVERTED TUNGSTEN LAMP-FIXTURES.
(By the courtesy of the *Electrical Field.*)

tions, is necessarily invariably the ideal method of lighting.

Photometry.

Let me now turn to one branch of the subject of illumination, as it is considered at present, in which very great developments have been made in recent years, namely, the science of *photometry* and the *measurement of light and illumination.* Now, this is a very vast subject, which has been very fully treated by Sir William Abney, Mr. Dibdin, and by the authorities who have lectured before this

Fig. 74.

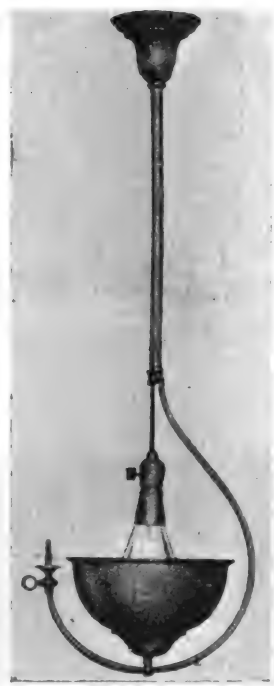
Twin Inverted Electric Fixture.
(A. D. Curtis and A. J. Morgan, "Trans. Illum. Eng. Soc." 1908).

Society in the past. I cannot hope, therefore, to go into details, but only to refer to one or two respects in which there have been such striking modifications from the point of view from which these matters are regarded.

At one time photometry was regarded merely as an interesting and perplexing scientific playground. Its vital application to practical problems was hardly realised. To-day matters are very different. We have at our disposal a bewildering choice of illuminants, many of them competing very closely in certain fields, and we need every method available of discriminating between their respective values. People now realise that the fundamental use of a source of light is to *illuminate*, and, therefore, it is obviously essential to systematise our methods of comparing their illuminating powers ; photometry, therefore, has become an art of industrial importance.

There have of late been a large number of ingenious types of photometers brought forward, so that to-day we have a choice of a number of excellent instruments, where a few years ago there were, perhaps, only two or

Fig. 75.



Combined Gas and Inverted Electric Fixture.

(A. D. Curtis and A. J. Morgan, "Trans. Illum. Eng. Soc." 1908).

three that were generally known. We have seen, for instance, the development of the "Flicker" photometer as a means of comparing the brightness of sources which differ in colour.

Illumination - Photometers.—But perhaps the most striking in principle has been the introduction of instruments intended to measure, not the illuminating power of sources, but the actual illumination available in the street, or at the table at which we sit.

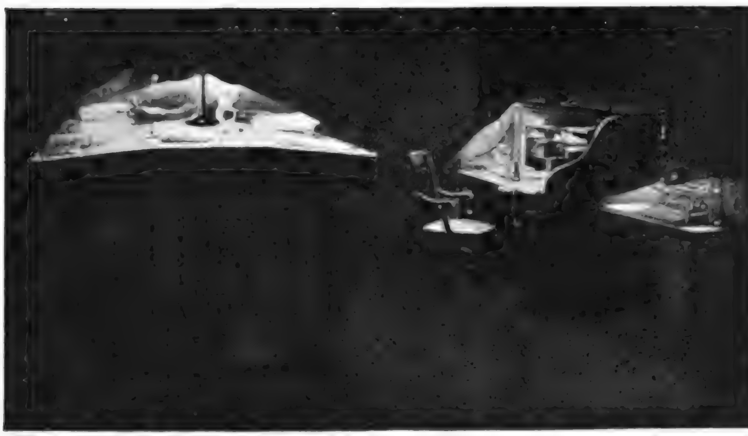
Naturally, it is essential to have a method of comparing the illuminating power of sources,

but this after all, though of technical importance, is only a step towards the attainment of our ultimate desires. What we really desire to know is the actual working illumination available.

In this connection, it is very interesting to recall some words of Sir William Preece, in a paper before the Royal Society, in 1883:—

"I have long felt," he said, "that to meet the case of electric lighting illumination, we must not depend

FIG. 76.

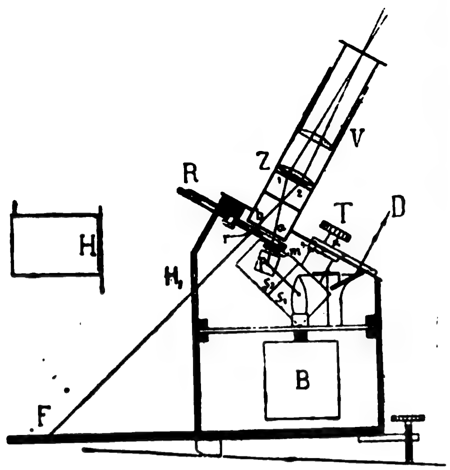


AD METHOD OF DESK-LIGHTING, EXCESSIVE CONTRAST. (Dr. L. Bell, "The Physiolog'cal Basis of Illumination," Proc. Am. Akad. of Arts, 1907.)

FIG. 77.

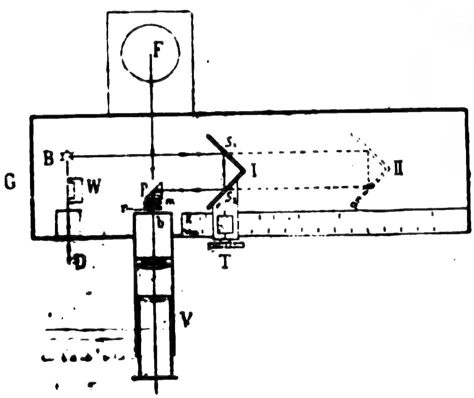
DESK LIGHTED BY REGINA ARC LAMP, HUNG HIGH AND GIVING RISE TO A GENERAL MODERATE ILLUMINATION.

FIG. 78a.



Elevation (Side).

FIG. 78b.



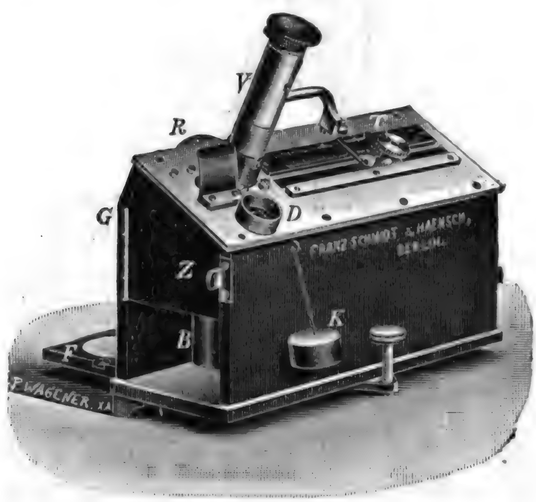
Plan.

he plaster of paris surface, F, receives the general illumination, the intensity of which it is desired to measure. The rays from this surface pass into the telescope of the instrument at *b*; its brightness is compared with that of the frosted glass, *m*, illuminated by the small benzine lamp, B, the rays from which enter at *a*. The flame-height of this lamp is regulated to exactly 20 mm., this height being controlled by observations through the window at D. The rays from the benzine lamp, before proceeding to illuminate the plate, *m*, must suffer reflection from the pair of mirrors, S_1, S_2, as shown. By moving these mirrors to and fro by means of a rack and pinion arrangement, we can weaken or strengthen the brightness of the illuminated plate, *m*, and can determine the relative values of the intensity of illumination, corresponding to equality of brightness in the field of view, by means of a scale calibrated direct in lux.

This alone would enable a range of illumination of 15 to 1 to be measured; in addition, a disc, *r*, is inserted in front of the plate *m*, which contains a series of graduated smoked glasses, the densities of which are such that the illumination read upon the scale must be multiplied by 0·01, 0·1, 1, 10, and 100 respectively.

upon any direct comparison between the light emitted by the source to be measured, and a given recognised standard of light; but that we should rather make our standard of comparison an area illuminated to a given intensity whatever be the source of light. We do not want to know so much the intensity of the light emitted by a lamp as the intensity of the illumination of the surface of the book we are reading, or of the paper on which we are writing, or of the walls on which we hang our pictures."

FIG. 78c.



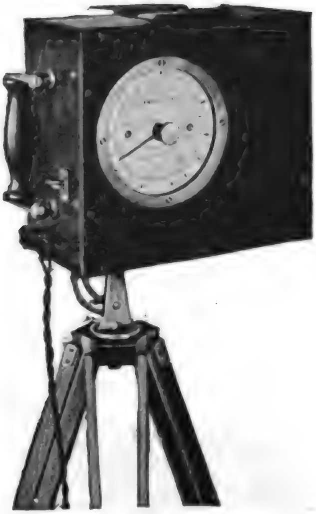
General View.

THE MARTENS ILLUMINATION-PHOTOMETER.

Moved by these considerations, Sir William Preece and Mr. A. P. Trotter were among the very earliest in this country to devise the "Illumination-Photometer," or, as they are now sometimes called, "Illuminometers."

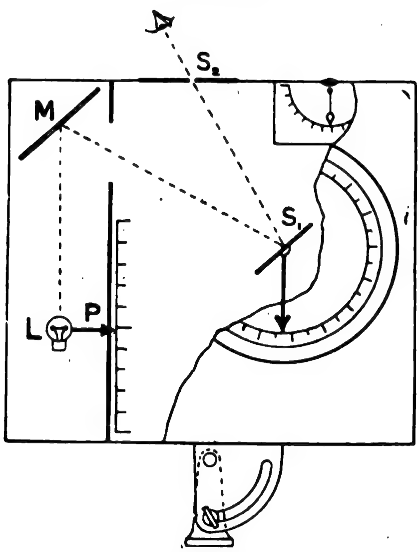
Quite recently the development of an interest in illumination has led many to realise the practical importance of such instruments, and types have been designed in England by Mr. H. T. Harrison, Messrs. Everett Edgcumbe and Co., Messrs. Alexander Wright and Co., and others. For a description of these and other instruments I should like to refer you to a lecture delivered by Mr. J. S. Dow at the Municipal Building and Public Health Exhibition in 1908 (see *Illuminating Engineer*, Vol. I, 1908, pp. 493-506). In addition a very large number of these instruments have been brought forward in Germany and the United States, and some of them formed the subject of an interesting paper by Mr. Preston Millar at the First Annual Convention of the Illuminating Engineering Society in 1907. What I wish to impress upon you is, however, that we

FIG. 79*a*.



EVERETT EDGCUMBE ILLUMINATION-PHOTOMETER. (General View.)

FIG. 79*b*.



EVERETT EDGCUMBE ILLUMINATION-PHOTOMETER. (Sectional View.)

The comparison source of light is in this case a small glow-lamp, L, the rays of light emitted by which strike the mirror, M, and are thus reflected on to the white diffusing screen, S_1, receiving the illumination it is desired to measure. The observer looks at the white diffusing screen, S_2; in this is cut a small aperture with very sharp edges. The observer is thus able to compare the brightness of the actual illumination of the surface, S_2, with that of the screen, S_1. The latter can be rotated so that the light strikes it at various inclinations, and the illumination is thus altered through a definite and convenient range from zero to two candle-feet. The actual value in candle-feet is obtained by observation of a pointer attached to the screen, S_1, moving on a scale on the outside of the box containing the photometer as shown in the diagram.

FIG. 80*a*.

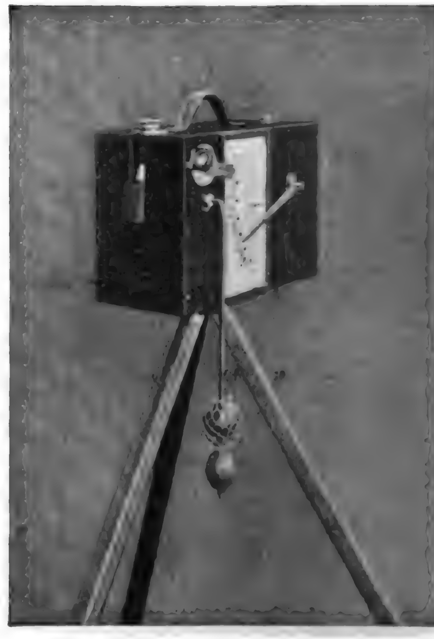
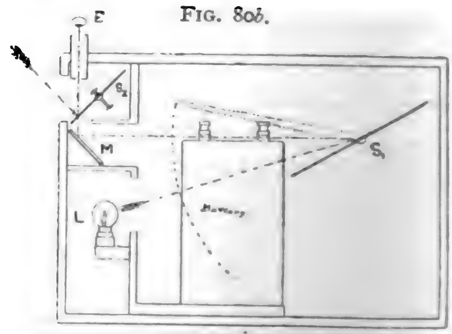


FIG. 80*b*.



HARRISON UNIVERSAL PHOTOMETER
(Messrs. Elliott Bros.).

The standard of light consists of a small glow-lamp at L, which receives current from a small accumulator within the instrument, and which illuminates the moveable screen S_1. S_2 represents a white sector-disc (*i.e.*, a disc from which two symmetrical sectors are cut out) which is driven by means of a small air-blast at any desired speed; on this screen is received the illumination which it is desired to measure.

The eye of the observer at E sees, in rapid succession, first the illuminated white surface of the sector S_2, and then, in the mirror M, the illuminated surface of the screen S_1. All that is necessary, therefore, is to alter the inclination of the screen S_1 until no flicker can be perceived by the eye. The surfaces S_1 and S_2 then appear equally bright. The actual illumination at the screen S_2 can be read off by the reading of a pointer attached to S_1, and moving on a scale graduated in candle-feet. In the position shown in the diagram the photometer is arranged to measure the intensity at an angle of 45 degrees to the vertical, but, by tilting the photometer, the intensity at any measured angle may also be obtained.

In a recent modification of the instrument provision is made for the observer to use the instrument *either* on the flicker or equality of brightness plan, and also for the measurement of illumination in a horizontal plane to be accomplished.

FIG. 81.

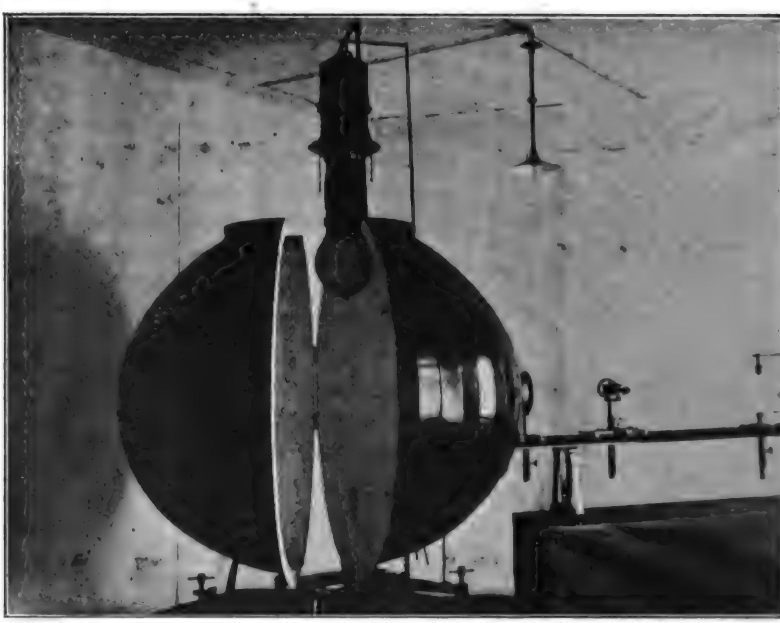
GENERAL VIEW OF THE GLOBE-PHOTOMETER.

(*See* Bloch, *Illuminating Engineer*, Vol. I., 1908, p. 280.)

have now available actual instruments for the measurement of illumination as opposed to light, and that, therefore, we may hope in the future to be able to specify the amount of illumination to be required to read by or for any other purpose, just as a grocer supplies one pound of tea neither more nor less—that is, if he is an honest grocer.

The Globe Photometer.—In passing, I may also mention one important development in light measurement, namely, the introduction of so-called integrating and globe-photometers, which are instruments devised to enable the total amount of light in all directions from a source to be obtained by a single measurement.

FIG. 82.



VIEW OF ULBRICHT GLOBE PHOTOMETER: THE GLOBE IS DIVIDED IN ORDER TO RENDER ITS INTERIOR ACCESSIBLE.

Fig. 81 and 82 display typical Ulbricht Globe Photometers; this instrument was discussed very fully by Dr. L. Bloch, Dr. Corsepius, and others in recent articles contributed to the *Illuminating Engineer* (Vol. I., 1908, pp. 274, 553, 801, &c). For detailed information readers are referred to these articles.

Briefly, however, the principle of the instrument is as follows:—The source, the light from which we desire to measure, is inserted within a hollow sphere, the interior surface of which is coated with some white diffusely-reflecting material. All the rays from the source in all directions are then reflected to and fro within the globe so that the intensity of illumination of the inner surface ultimately comes to be a measure of the total amount of light given out by the source. If need be the two hemispheres may be first separated as in Fig. 82 and the lamp placed inside. The two halves can then be closed again and the illumination of the inner surface studied through a little observation window. As a rule, it is unnecessary to open the globe, the lamp to be tested being merely lowered through a suitable hole at the top. As will be seen from these illustrations such globes are frequently of considerable size. This is necessary because the theory of the instrument demands that its dimensions should be as large as possible in comparison with the lamp studied, and the instrument is frequently used for the testing of large arclamps, &c.

I wish to repeat, therefore, that the subject of the measurement of light is now being lifted out of the state of uncertainty in which it so long existed, and is now coming to be looked upon as a feasible and recognised process.

The International Unit of Light.—And lastly, let me dwell upon one aspect of this subject which is particularly satisfactory. I allude to the efforts that are now being made

to establish measurements of light on a definite international basis. At one time the units of light in different countries were very different, and, as the general public and even the great majority of engineers did not realise this, much confusion naturally arose in expressing the intensity of different lamps. In addition, the actual methods of carrying out photometrical tests differed very much in different countries, and also (as they do even to-day) between representatives of different systems of lighting even in the same country. Within the last few years, however, Government laboratories have been established in the chief countries of Europe and in the United States, and a determined effort has been made to bring matters to a common basis, and to decide accurately the relations between the standards used in different countries. For this purpose carefully standardised glow lamps are now regularly exchanged and compared between the chief laboratories in England, France, Germany, and the United States. There is now, therefore, no fear that these standards may not be maintained constant, and their relation is accurately known.

The next step will be for all the nations to agree upon a common unit of light, and I am glad to say that considerable progress has been made in this direction, and that a fair share of the credit attaching to these efforts is due to the Illuminating Engineering Society in the United States, who have been working in harmony with the American Institution of Electrical Engineers, and the American Gas Institute, for the furtherance of this end. It cannot, however, be too strongly emphasised that no such agreement could be of permanent value unless it satisfies not only representatives of different countries, but also different representatives of the different systems of lighting in use in those countries. It was with the object of urging this view that I was present at the meeting of the International Electrotechnical Commission in this country last year, and strongly supported the recommendation on that occasion that no definite steps should be taken until an opportunity was provided for the expression of the views of those representing not only electric lighting but also gas and other systems. I am glad to say that this has been borne in mind by the sub-committee dealing with the standard of light, who have co-opted Mr. J. W. Helps and Dr. C. V. Boys, as representatives of the gas industry, and the gas referees.

[Since the date of this lecture an important announcement has been made simultaneously by the recognised official photometrical laboratories in Great Britain, France, and the United States on the subject of a proposed international unit. The ratios between units employed in the chief European nations and the United States have recently been redetermined, and it has been found that those used in France and this country are in practical agreement; the American unit was 1·6 per cent. higher than both, and the German unit 0·9 times this value. The United States have now agreed to lower their unit by 1·6 per cent. so that in future one and the same unit will be employed in Great Britain, France, and the United States, while the value employed in Germany is related to the international unit by the convenient fraction 0·9. Some objection to the term "international unit" has been raised in Germany on the ground that the existence of such a unit strictly demands an adequate international standard (which we have not as yet succeeded in obtaining). But whatever view may be taken in this matter, the practical agreement attained between the units in these three countries is a very satisfactory simplification, and the United States deserve our gratitude not only for having taken up the matter so sympathetically, but also for making a certain concession in lowering their unit as explained above. It may be mentioned that M. Blondel has recently pointed out that a proper name for the international unit is needed and propose the Greek terms "Phos" or "Pyr," or the contraction of a scientist's "Vi" for "Violle" (*Illuminating Engineering*, London, Aug., 1909.)]

One by one, therefore, the various misunderstandings characteristic of photometry are being removed, and we may hope to see in the future this method of measuring recognised to be as definite a process as the measurement of gas, or electricity, or even weight.

THE MARINE STEAM TURBINE.*

The rapid development of the marine steam turbine during the last seven years, constitutes one of the romances of engineering, and the magnitude of the work done and the revolution initiated by Mr. Charles Parsons will be more justly appreciated hereafter than it can be at present. In some quarters there is a tendency to deal critically with details, and to disregard broader views of the situation as it stands to-

* Extracted from the Presidential Address of Sir William H. White, K.C.B., F.R.S., to the Engineering Section of the British Association, Winnipeg, 1909.

day. In May, 1909, there were 273 vessels built and under construction, in which steam turbines of the Parsons type are employed, the total horse-power being more than three and a half millions. In the Royal Navy, every new warship, from the torpedo-boat up to the largest battleships and armoured cruisers, is fitted with turbine engines; and the performances of vessels which have been tested on service have been completely satisfactory, in many instances surpassing all records for powers developed and speeds attained. In the war-fleets of the world this example is being imitated, although in some cases it was at first criticised or condemned. In the mercantile marine, as a whole, while the new system has not made equal advance, many notable examples can be found of what can be accomplished by its adoption. It is now admitted that steam turbines enable higher speeds to be attained in vessels of given dimensions; and in steamers built for cross-channel and special services, where high speed is essential, and coal consumption relatively unimportant, turbines have already ousted reciprocating engines. For oversea service and long voyages an impression has existed that the coal consumption of turbine-engined ships would considerably exceed that of ships driven by triple or quadruple expansion reciprocating engines. Critics have dwelt on the reticence in regard to actual rates of coal consumption practised by owners of turbine steamships. Naturally there are other reasons for reticence than those which would arise if the coal consumption were excessive; but pioneers in the use of turbine machinery may reasonably claim the right of non-publication of results of trials in the making of which they have incurred large expenditure, and taken considerable risks if they think that silence is beneficial to their business interests. Even if it were true that in the earliest applications of the new system economic results had not been obtained equal to those realised in reciprocating engines which have been gradually improved during half a century, that circumstance should not be regarded as a bar to acceptance of a type of engine that admittedly possesses very great advantages in other ways, but should be regarded as an incentives, to improvements that would secure greater economy of coal. The evidence available, however, does not confirm the adverse view, and those familiar with the facts do not admit its truth. One example may be cited as it affects the Canadian service. In June, 1907, it was authoritatively stated that in the Allan liner *Virginian* the reports which had been circulated respecting the excessive coal consumption were unfounded, that the vessel was making passages at speeds of 17½ to 17¾ knots, as against the 17 knots estimated, and the rate of coal consumption was really about 1·4 lbs. per indicated horse-power which would have been required to attain this speed if the vessel had been fitted with reciprocating engines. This result compares well with the consumption in ordinary passenger steamers running at high speeds in proportion to their dimensions, although in large cargo steamers and vessels of the intermediate type, working under much easier conditions and at very low speeds in proportion to dimensions, lower rates of consumption may be obtained. With these latter vessels the fair comparison is the combination system and not the pure turbine type which is adapted for high speeds.

The crowning triumph of the marine steam turbine up to the present time is to be found in the great Cunard steamships *Lusitania* and *Mauretania.* The passages made this year by the latter ship since she was refitted have been marvellously regular, and the 25 knots average across the Atlantic, which was the maximum contemplated in the agreement between the Government and the Cunard Company, has been continuously exceeded. As one intimately concerned with the design of the *Mauretania*, who has had large experience in ship design, has made a life-long study of the laws of steamship performance, and had the honour of serving on the committee which recommended the employment of turbines in these great ships, the writer ventures to assert that equal results could not possibly have been obtained with reciprocating engines in vessels of the same form and dimensions. Contrary opinions have been expressed, but they have been based upon incorrect data or have omitted consideration of the fact that in vessels of such great engine-power it was necessary to have time to perfect the organisation of the staff in order to secure uniform conditions of stoking and steam production, and to bring the "human element" into a condition which would ensure the highest degree of efficiency in working the propelling apparatus. This necessity for time and training has been illustrated again and again in the case of new types of Transatlantic steamers, including some which held the record for speed prior to the appearance of the Cunarders. In the *Lusitania* and *Mauretania* the engine-power is fully 60 per cent. greater than that of their swiftest predecessors, yet no similar allowance appears to have been thought necessary by some critics, who assumed that performances on the earlier voyages represented the maximum capabilities of the vessels. Subsequent events have shown this view to be fallacious and have justified the recommendation of the Turbine Committee and the action of the Cunard directors. Allegations made in regard to excessive coal consumption have also been disproved by experience; and in this respect the anticipations of the committee and of Mr. Parsons have been fully realised.

The marvellous regularity maintained by the *Mauretania* on a long sequence of consecutive Transatlantic passages—made under varying and in many cases very adverse conditions of wind, weather, and sea—illustrates once more, and on an unprecedented scale, the influence which large dimensions have upon the power of maintaining speed at sea. Starting from the eastward passage, beginning on February 3rd last, and taking twelve passages (westward and east ward) which followed, the average speed for the

thirteen passages, approaching 40,000 sea miles in length, has been 25¼ knots; the lowest average speed in the series has been 25·2 knots, the highest average speed 25·88 knots. Many of the winter passages in this series were made in winter weather against strong winds and high seas, which would have considerably reduced the speed of her predecessors, but had small influence on the *Mauretania*. In many instances delays have been caused by fogs.

On seven consecutive passages made since the beginning of last May the average speed of the *Mauretania* in covering about 20,000 sea-miles has been 25·68 knots, the minimum speed for the passage having been 25·62 knots, and the maximum 25·88 knots. On her contract trials, the *Mauretania* maintained an average speed of 26·04 knots for a distance somewhat exceeding 1,200 knots, the steaming time being rather less than forty-eight hours. On the passage when she averaged 25·88 knots, she ran 1,215 knots from noon on June 17th to noon on June 19th (about forty-six hours), at an average speed of 26·23 knots, and by noon on the 20th had covered 1,817 knots at an average speed of 26·18 knots for 69 hours. The ship has, therefore, surpassed on service her performance on the contract trial.

In view of the foregoing facts and of others of a similar nature, it is reasonable to assume that as experience is enlarged and information is accumulated in regard to forms of propellers likely to prove most efficient in association with quick-running turbines, sensibly improved performances will be obtained. At present, in comparisons made between the efficiency of reciprocating-engined ships and turbine-engined ships, the former have the great advantage attaching to long use and extended experiment; but this is not a permanent advantage, and it may be expected that, good as the position is to which the marine steam turbine has obtained in the brief period it has been in practical use, that position will be gradually improved. Whether or not other forms of propelling apparatus in their turn will surpass the steam turbine it would be unwise to predict. Internal combustion engines are regarded in some quarters as dangerous and probably successful rivals to steam turbines in the near future. Within certain limits of size, internal combustion engines no doubt answer admirably; but as dimensions and individual power of the engines are increased, the difficulties to be overcome also rapidly increase, and the fact is fully recognised by those having the best knowledge of those types of prime movers. On the whole, therefore, it seems probable that the turbine will not soon be displaced, whatever may happen eventually.

THE MINING INDUSTRIES OF GREECE.

Greece is peculiarly a mineral-producing country, possessing many mines, especially of iron, lead, zinc, silver, &c. The mines are found chiefly on the eastern shores of the peninsula and in the islands of the Ægean, as these parts of the country are the oldest geologically, and of volcanic origin. Notwithstanding this mineral wealth, the industrial development of the country has been slow, on account of the lack of fuel, which is nowhere found in sufficient quantity. For this reason most of the minerals are exported in a crude state after the simplest possible preparation, and the exploiting only of those metals has been found to be profitable which are valuable without being bulky, and are easily mined and transported. Recently also, on account of the rise in the value of the paper drachma, mines have been shut down which formerly were worked with profit. Labour and other expenses must be met now with paper that is worth nearly its face value in gold. The following mines are in operation:—Hematite iron ore mines in Laurium, Skyros, Kythnos, Siphnos, Seriphos, Antiparos, Mykonos, Atalante; manganese iron ore mines in Laurium, Kimolos, and Syra; chrome iron ore mines in Larymne; lead ore mines in Laurium, Siphnos, and Thera; zinc mines in Laurium, Siphnos, Antiparos; manganese mines in Milos; chromium mines in Pharsala and Lamia. But for the lack of coal Greece would have been an important steel and iron producing country. Experiments are being made as to the possibility of using lignite for smelting purposes, of which considerable quantities are found. According to the American Consul at Athens, the iron ores are hematite, generally of high grade, and manganese in veins piercing limestone or volcanic layers. Often, as at Laurium, they appear as coverings for beds of lead, zinc, and copper. One of the best mines in Greece, now being worked, is found in the island of Seriphos. This mine produced and sold during the years 1901 to 1907 iron ore valued at £428,000. Activity in iron mining fell off considerably in 1908 on account of the crisis in America, on the Continent, and in Great Britain. The lead ores are found for the most part between volcanic strata, in the form of lead sulphide. Mines of this kind exist in the island of Mykonos. At Laurium the iron is found between layers of schist or marble, together with ores of zinc and iron carbide. These mines were worked from ancient times, and the smelting was done on the spot. The residue of the lead, cast aside by the ancients, is worked over to-day by the Greek Mining Company of Laurium. The ancients neglected also the zinc ore, the utility of which was unknown to them, and this is found as thrown out by them, and carefully worked. Deep mining is limited at Laurium on account of the water, which rises everywhere to a slight distance below the level of the sea. Zinc is also mined at Laurium. The zinc oxide is exported in its natural state. There are also here kilns for the roasting of the lead oxide. Other mineral products in Greece which are taken out at a profit are emery, magnesite, gypsum, kaolin, and sulphur. Many other mineral substances exist in Greece of possible value, which have either not been worked at all or only worked on a small scale. Among these may be

mentioned talc, chalk, ochre, baryta, &c. The quality of emery depends upon the percentage of corundum it contains and the quantity of iron in mixture. Pure corundum is not found. It is used for the polishing of hard substances, and is, therefore, of great industrial value. The world's annual production of emery is about 35,000 tons, of which Greece produces 9,000 tons from the island of Naxos. The right of mining the emery is enjoyed by the inhabitants of certain districts, the Government transporting the product to Syra, where it is sold for about £4 per ton. The Naxos emery contains about 60 per cent. of corundum. Magnesite is of great industrial value on account of its resistance to heat, which renders it suitable for the lining of furnaces and for fire-bricks. It is also used for making cement. Magnesite is found principally in the island of Euboea. It is mined by the Company of Municipal and Public Works, the Anglo-Greek Company, and the Magnesite Company. In the island of Milos are found gypsum and sulphur, and its millstones are famous throughout the East. It is said that the mining industry is capable of great development in Greece, and that many mines that are at present neglected, and others that have not yet been discovered, will be worked profitably in the future.

COMPULSORY PILOTAGE.

The Board of Trade Committee, under the chairmanship of Sir Kenelm Digby, K.C.B., formerly Under Secretary of State at the Home Office, which has been appointed to consider and report on the Pilotage Laws, and to which reference was made in a note on page 792 of the *Journal*, has a very thorny topic to examine, and one very productive of litigation in the past. The last exhaustive inquiry into the matter was made by the Royal Commission on the Port of London in 1900–1902, and much striking evidence was elicited. So far as London is concerned, pilotage is regulated by the Trinity House Corporation, who exercise jurisdiction in respect of 37 "outport" districts as well. But nearly all the more important ports in the British Isles have pilotage authorities of their own, *i.e.*, a Standing Committee or a special statutory Pilotage Board, and thus are independent of the Trinity House. The most vexed question in pilotage matters, however, is the maintenance of compulsory pilotage on the Thames and in certain other ports, where it is generally regarded as a very serious grievance, especially by wharfingers and barge-owners. The original rule was that all pilotage should be compulsory within the London district and the Trinity House outport districts, but the rule, as was pointed out in the *Journal* of the 13th August, practically ceased to be a rule, owing to the multiplicity and complication of the exceptions, and, in the words of the Royal Commission, "the whole law is in a chaotic condition, and is a fruitful source of litigation and trouble." According to the Merchant Shipping Act of 1894, which, however, was mainly a consolidating Act of previous enactments, an owner or master of a ship is not answerable for loss or damage occasioned by the fault or incapacity of any qualified pilot in charge of that ship in districts where pilotage is compulsory. The legal principle upon which this rule is founded is that a man is liable for the acts of those he voluntarily employs, but not for the acts of those whom he is compelled to employ. Unfortunately, however, this leads to an inversion of what has been laid down by the Admiralty as the true rule, *i.e.*, that a pilot should be the adviser of the captain, but should not take his responsibilities. It may thus be imagined what a confusion arises, and instances of the most extraordinary anomalies and injustices were given by various witnesses before the Royal Commission. It was hoped the Commissioners would have seen their way to recommend the abolition of compulsory pilotage altogether, and the transfer of buoying and pilotage within the limits of the Port of London to the new authority. The latter reform was duly recommended by the Commissioners (but not included by the Government in the Act), and, with regard to the question of compulsory pilotage and the peculiar hardship of the exemption of ships when in charge of a pilot from liability for damages, the Commissioners left it to the new Port Authority for London to apply to the Board of Trade for a provisional order exempting all ships in the Port of London from compulsory pilotage. As the Port Authority is now in full swing it would be, of course, within their competence to apply for such an order. But, no doubt, the Board of Trade feel that if so important an amendment of the general law be carried out it is better it should be preceded by a special inquiry *ad hoc*, and not upon the initiative of a local authority, however powerful or dignified. Hence the new Committee, the proceedings of which will be undoubtedly watched with attention by shipowners, bargeowners, wharfingers, and other great river business interests.

RABBITS AND SHEEP IN AUSTRALIA.

A correspondent of the *Economist* contributes some interesting information relating to the damage done by rabbits to the grazing districts of Australia. At the present day Australia depastures nearly 100,000,000 sheep; but, vast as this number is, a leading South Australian has given it as his opinion that "the country is carrying a greater weight of rabbits than of sheep." Accounts from various squatters seem to confirm this opinion; in any case, it is a matter of fact that the rabbits have driven out of great districts both the sheep and their owners, rendering the country so abandoned quite useless.

The fecundity of rabbits is appalling. Naturalists reckon that under favourable circumstances, such as obtain in Australia, a single couple will increase to four millions in five years; and certainly in the 35

years that have elapsed since the first half-dozen couples were turned loose in Victoria, their descendants have over-run the whole island continent. So universal is the plague that it is now acknowledged that neither the pastoral nor the agricultural industry can be carried on unless runs and farms are securely protected with rabbit-proof netting. "Millions of miles" of fencing, according to the correspondent, have been erected, the cost of which can never be ascertained. The expense, however, does not end here. On some well-equipped farms, in spite of the most careful fencing, it is necessary to have trappers, diggers-out, and poison carts constantly employed in order to keep the rabbits outside the netting. On one such farm the outlay in these directions alone is, on an average, £1,200 a year. On some small farms, by simple netting in the water tanks during the dry season, as many as 10,000 rabbits have been caught and destroyed in three or four nights, while some holders of large properties state that they have killed between 150,000 and 250,000 in a year. According to one leading pastoralist, this rabbit plague is costing the Commonwealth about £10,000,000 *per annum*; for if the vermin could be exterminated, one consequence would be a great increase in the number of sheep depastured, and a consequent rise in the exports of wool, amounting, in the opinion of this authority, to not less than 500,000 bales a year.

In spite of these enormous losses no serious attempt has been made by Government to deal with the problem. No fair trial has been given to Dr. Danysz's specific. It should have been possible to set apart "a few thousand square miles of what is known as 'rabbit-riddled' country for the purpose of experimenting with the virus; but the friends of the rabbit-trapper . . . in the various legislatures have been too strong for the friends of the sheep-farmer." Public opinion, however (according to the *Economist's* correspondent) is ripening on the question, and it is certain that before long not only the Federal, but State Governments will be compelled to take decisive measures.

HOME INDUSTRIES.

The Wastage of Shipping.—"Lloyd's Register" have just published their statistical summary of vessels totally lost, condemned, &c., during 1908. The gross reduction in the effective mercantile marine of the world during the year, amounted to 800 vessels, of 809,292 tons, excluding all vessels of less than 100 tons. This compares with 868 vessels, of 851,224 tons in 1907. Of this total, the steam tonnage was 566,487 tons, the sailing 242,805 tons. The average percentage lost, &c., of British-owned ships, as recorded in "Lloyd's Register" book, shows little variation. For the quinquennial period, 1898-1902, the percentage of steamers lost was 1·93, and of sailing vessels 4·95; for the period 1903-7, 1·90 and 4·98 respectively, whilst, for 1908, the percentages were 1·82 and 4·68. It will be noticed that the percentage of sailing vessels lost is much higher than that of steamers. Strandings and kindred casualties, comprised under the term "wrecked," are much the most general cause of disaster; 43·5 per cent. of the losses of steamers, and 33·8 per cent. of the losses of sailing vessels, come under this head. The next most common termination of a vessel's career is due to condemnation, breaking up, &c., 20·4 per cent. of the steamers, and 27·8 per cent. of the sailing vessels removed from the mercantile fleets of the world being accounted for in this way. Lloyd's figures show that, large as is the absolute annual loss of vessels belonging to the British mercantile marine, it is only a small percentage of the whole, and compares favourably, anyway so far as steamships are concerned, with the loss sustained by the mercantile fleets of other leading centres. The percentage of steamers lost by France last year was 1·49, by Germany 1·20, by Norway 2·13, and by Japan 2·20, the British loss being only 1·11. We are less fortunate with sailing vessels. Of these, France lost 2·91 per cent., Germany 2·70, as compared with our 3·49 per cent. But Norway lost 4·65 per cent., Sweden 8·01 per cent., and Holland (which only owns 34,750 tons) no less than 10·63 per cent.

British Railways.—The returns of the British railways for the half-year ended June 30 show a marked recovery in the position of the leading companies. There was a further small decline in gross receipts of £264,811 or ·06 per cent., but the net earnings increased by £698,238, or 4·7 per cent. The expenses of the 19 principal English railways were reduced £963,000, or 3·3 per cent., a reduction mainly due to the fall in the price of coal, but also to some extent to real economy. The coal bill fell £549,661 or 17·6 per cent., and expenditure other than for coal was reduced nearly £400,000, mostly owing to the curtailment of goods and passenger train mileage. The reduction in freight train mileage was 5·6 for the half-year, and in passenger train mileage 1·2 per cent. The net earnings of the half-year exceeded by £698,238, or 4·7 per cent., the earnings of the corresponding six months of 1908, and the dividend earned upon the ordinary shares was at the rate of 2·96 per annum, as against 2·53 per cent. per annum for 1908. The average dividend distributed for the half-year has been at the rate of 3½ per cent. per annum, in comparison with 2·86 per cent. per annum a year ago, an increase of ·26 per cent. Thirteen out of the 19 companies increased their dividends, five maintained them, one only had to make a reduction. There is good reason to believe that the shrinkage in trade which adversely affected railway receipts in this country during the last two years is now at an end, and, indeed, appreciable expansions in earnings are already taking place. Again, methods of administration and working have improved. There has been less rash expenditure of capital, and greater avoidance of unwise competition. The outlook for the railway industry is decidedly brighter than it was.

The Coal Industry.—Whilst the demand for iron, especially for steel making, is increasing, the coal trade remains depressed. It would have been strange had it been otherwise. There has been over supply of coal. Foreign competition becomes more serious every year, and the Eight Hours Act, which bears on British coal alone, cannot fail to work for the foreigner. The exports of coal for the seven months ended July show an excess of only 180,000 tons over those for the corresponding period of 1908, which is far short of the normal rate of annual increase. But it is the home market which shows the serious shrinkage. Many factors have combined to bring about this result. During the late spell of dull trade the householder has been more careful of his coals; then gas stoves for cooking purposes are largely on the increase, and the use of electricity has its effect. The industrial consumption has been largely below normal for many months past, and the coal bills given in the half-yearly reports of the railway companies show extensive savings not all due to lower prices. The shipping depression has led to reduced consumption of coal for bunker purposes, and the threat of a strike of coal miners, not only in Scotland and Wales but in England, led to consumers laying in large stores of coal which have now to be absorbed before holders of them can be in the market again to any normal extent. But low as is the present level of prices it is higher than it would have been but for the Eight Hours Act, which has been the cause of the higher rates of wages now current.

The Cotton Crop.—Messrs. Neill Brothers have issued a memorandum on the cotton position, from which it may be inferred that in their belief the reports of bad weather have been exaggerated, but that the conditions in Texas are really serious. It is, however, too early to come to any definite conclusions as to the crop. That for 1908-9—for statistical purposes it is completed on August 31—has exceeded the totals of the two "bumper" crops of 1904-5 and 1906-7, a fact to be remembered when dealing with official estimates. According to the figures supplied by the New York Cotton Exchange the total for 1908-9 up to August 26 was 13,647,000 bales, as against 11,377,000 bales for the corresponding period of 1907-8, and 13,506,000 bales for 1906-7. In 1904-5 the total crop marketed reached 13,557,000 bales, so that 1908-9 stands well to the front. In America and on the Continent the takings by the mills are increasing; in Lancashire the recovery in trade has still to come, but margins are less.

A New Domesday Book.—The intention of the Government to value the land of the United Kingdom may serve to recall the almost forgotten Domesday Book of 1876. This compilation purported to give the proprietorship, acreage, and rental of England and Wales in the year 1874-5 exclusive of London. It had been alleged that there were only about 10,000 landowners in the country, and the return was ordered for the purpose of showing the facts, which were, according to the return, that there were in all 972,836 landed proprietors with an estimated rental of over £59,000,000, and owning in the aggregate 33,013,514 acres. Of these proprietors more than 700,000 owned less than a single acre; 121,983 owned under ten acres, while over 3,000,000 acres were owned by some 10,000 persons. It was, however, demonstrated that the return was, in some respects, misleading. For example, it was made by counties, and large owners, who owned estates in several, were counted once for each county, and in some cases figured as small proprietors. Again, the average of the large proprietors was under-estimated, as all woods, except saleable underwoods, were excluded from the return. Clergymen were often put down as the private proprietors of their own glebe lands, and no attempt was made to distinguish between rental derived from town and country property. Accepting the figures of the old Domesday and the new for the purpose of comparison, it appeared that in proportion to population the number of landowners was tenfold greater in the eleventh century than in the nineteenth.

Yarn out of Paper.—The United States Consul-General at Stockholm, in a recent report, gives some details respecting an industry about to be established in Sweden. He says that in Halmstad, Mr. Pontus Holmström is about to start a spinning mill for making yarn out of paper. Such mills already exist in Germany and France, and mention has been made of them in these Notes. So far, the manufacture of rugs and carpets seems to be the best practical use of this new paper yarn. It is stated that people in Sweden, especially in the province of Ostergötland, are already making carpets with paper welt. Narrow rolls of paper tape are used, but this, of course, is not spun.

OBITUARY.

PROFESSOR EMIL CHR. HANSEN, M.D., Ph.D. —The death occurred on August 26th of Professor E. C. Hansen, the head of the department of physiological fermentation in the laboratory of the Institute of Technical and Physiological Fermentation at Carlsberg, Copenhagen. Professor Hansen was born in 1842. He studied at the University of Copenhagen from 1871 to 1876 and in the following year entered the Carlsberg Institute. Devoting himself to independent scientific research he became known as an authority on fermentation and the inventor of a method of producing pure yeast, which is now employed almost universally in the breweries of Denmark, Norway and Sweden, and in most of the chief breweries of Germany, Holland and America. He wrote several treatises on fermentation, including "Experimental Studies on the Variation of Yeast-cells," which appeared in the "Annals of Botany," 1895. He was a Foreign Member of the Linnean Society, and in 1905 he was elected an Honorary Corresponding Member of the Royal Society of Arts.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY

CANTOR LECTURES.

MODERN METHODS OF ARTIFICIAL ILLUMINATION.

By Leon Gaster, A.M.I.E.E.
(Editor of the *Illuminating Engineer.*)

PART VI.*

We may now turn to another section of my lecture and refer, necessarily very briefly, to a few of the most obvious cases of lighting which deserve particularly careful study. In doing so I ask you to bear in mind what I have just said about the necessity for measuring light. This is the keynote of successful "Illuminating Engineering," for it is only by means of actual measurement, however faulty our apparatus may be, that we can preserve a permanent record of prevailing conditions of illumination. Naturally, our methods are still crude, but immense advances have been made since their practical value has been realised, and I confidently expect yet more remarkable developments in the future.

School-lighting.

I should like first to say a few words upon the subject of school-lighting. It would seem to be so obvious that good illumination bears an intimate relation to health, that the importance of lighting schools, in which children are confined at a crucial period in their physiological development, in a thoroughly satisfactory manner would be admitted at once. I am glad to say that here again the Royal Society of Arts has not been found wanting, for recommendations on this point were made by Mr. Brudenell Carter as far back as 1885 in a paper on the "Influence of Civilization on Eyesight," and again in 1898 on "The Eyesight of Children."

I have no time to quote the exhaustive data that have been accumulated to prove that the eyesight of children steadily deteriorates during school life, but I may say that they are very convincing, not only in England but possibly even to a greater extent in Germany and the United States. I may, however, refer you to an article by myself in the *Journal of the Royal Society of Arts*, of August 21st, 1908, and to a special section in the first number of the *Illuminating Engineer*, January, 1908, in which this matter is exhaustively treated.

Dr. H. Wright Thompson, oculist to the School Board of Glasgow, has found that 35 per cent. of the children in the 67 schools visited by him had more or less defective sight.

Professor Scott in the United States has quoted even higher figures, and summed up his remarks in the mournful words:—

> "Because of the lack of attention that is paid to the light actually present in the schoolroom, and because of the great difficulty in adjusting our windows and shades to the varying intensities of the external sources of light, it is not surprising that we should find in our schoolrooms conditions of light so bad during many hours of the day that the reading of ordinary printed matter without undue strain on the eyes is impossible."

We find, indeed, that it is generally admitted, as, of course, it stands to reason it would be, that defective eyesight is, at least, partially due to bad lighting in the schoolroom. The light may be insufficient in quantity and so strain the eyes of the child attempting to read. It may also come from the wrong direction, and Mr. Brudenell Carter has shown how this may affect the attitude of a child seated at his desk, and indirectly affect his growth.

In addition, it must be recognised that each portion of the schoolroom requires separate attention, and presents a separate problem.

* The Course consisted of four lectures, delivered on February 15th and 22nd, and March 1st and 8th. In re-arranging the material for publication in the *Journal*, the lecturer has preferred to divide it into six parts.

Thus the children's desks must be adequately illuminated, but special provision is necessary for the illumination of the blackboard and for the table at which the teacher is standing.

Another cause to which short sight has been attributed is the use of type that is too small for the growing child to see with comfort. This has been alluded to by Dr. H. E. J. Biss (*Illuminating Engineer*, Vol. I, p. 190), and it is interesting to note that, by the advice of Mr. Brudenell Carter, *The Times* have recently decided to alter the nature of their smaller type.

The importance of this question to the nation will be understood from the fact that there are over 1,000,000 children in the schools of London alone. It is interesting to recall that Mr. Brudenell Carter, as far back as 1885, approached the School Board of London, and tried to induce them to organise periodical testing of the eyes of their children.

That Mr. Carter had ample grounds for urging this improvement will be understood from the decisive nature of the results of the tests of the German Professor Cohn, who in 1865 examined the eyes of about 10,000 school children and found that 1,630 of these had eyes of faulty shape, 1,072 being short-sighted, 139 flat eyed, 23 suffering from astigmatism, and 396 from the results of previous diseases. In addition, Mr. Carter's friend, Mr. Adams Frost, had examined a Board school in the South of London and found that 73 children out of 267, or rather more than one-fourth, suffered from defective vision. It was rational to conclude, therefore, that the possibility of equally bad conditions prevailing in other schools ought at least to be examined. On this occasion, as we have since had ample reason to regret, this recommendation was not complied with, but at the present day our views are more enlightened, and only last year it became obligatory for the London County Council for the first time to undertake periodical tests of this description.

But I feel constrained to point out that tests of eyesight alone are insufficient unless accompanied by some study of the conditions of illumination. It is no use studying a disease without also taking account of the conditions by which it was produced. In this connection it is satisfactory to note that Dr. Kerr, medical officer to the London County Council, made special reference to this matter in his report in 1908. I may quote the following words :—

"A normal person of middle-age will distinguish characters on paper in a poor light with greater readiness than a child, because the characters are more familiar to the adult and so much more easily recognised. Conversely, a child requires a better light to learn to read by than does an adult, to whom reading is second nature. From a large number of experiments, the least illumination permissible on the school desk of a child has been found to be equal to 10 candle-metres (*i.e.*, roughly 1 foot-candle)."

Dr. Kerr then studied the illumination in 165 schools, and found that the artificial illumination of about 20 per cent. was classed as only "fair," while 18 were considered "bad;" very similar figures were quoted of the daylight illumination.

In the report which has just been issued for the subsequent year stress is again laid on the part played by good illumination. Thus Dr. Woodcock points out that, apart from eye-troubles, nervous habits such as squinting, twitching of the eyebrows, &c., giving rise to a strained expression, are often the direct result of the close attention and effort involved in certain kinds of work (such as sewing) which impose a tax on the eyes. For instance, reference is made to a class of 28 children who were hemming in a poorly-lighted room. A few minutes after work had commenced ten were squinting, eleven knitting their eyebrows, two standing up to sew, and half-way through the hour four children exhibited nervous defects. "Artificial light in schools" this observer goes on to remark "is practically always insufficient for this work" (*i.e.* fine work involving matching of colours and texture with precision). "From October to March," she says further, "no needlework should be allowed after 3 p.m., and during November 15th to February 15th no needlework should be permitted in the afternoon at all."

In this report Dr. Kerr again gives some figures relating to the conditions of illumination in various schools; they are as follows:—

QUALITY OF LIGHTING.

April 1st, 1907, to March 31st, 1908.

Non-Provided Schools—		
Good	57	65 per cent. approx.
Fair	10	11 ,, ,,
Bad	21	24 ,, ,,
Council Schools—		
Good	191	73 per cent. approx.
Fair	16	6 ,, ,,
Bad	52	14 ,, ,,

April 1st to December 31st, 1908.

Non-Provided Schools—		
Good	18	72 per cent. approx.
Fair	3	12 ,, ,,
Bad	4	16 ,, ,,

Council Schools—

Good........	237	81 per cent. approx.
Fair	23	8 ,, ,,
Bad	33	11 ,, ,,

Now, when the appointed authorities take the view explained above, it is sufficient to justify the contention that the study of the illumination in schools is a matter that deserves very careful attention indeed.

Factory and Barrack Lighting.

While dealing with the hygienic aspects of illumination, I may refer to the lighting of factories and barracks. Here again, although we are dealing mainly with adults, instead of children, we have a case of large numbers of people constantly at work under more or less stereotyped conditions. Think how many soldiers are constantly confined in barracks in this country.

I was given to understand that the War Office authorities were paying great attention to this subject, being desirous of adopting some definite plan for supervising the lighting in these cases, so as to render it in everyway most efficient.

In the same way, it would seem to be a truism to say that good illumination in factories is not only absolutely essential to the work-people, but expedient from the point of view of the employer. Good illumination, as I have tried to show, is not a luxury but a necessity, and therefore ought to be insisted upon every whit as keenly as the provision for adequate sanitation and ventilation, which, by the way, have only become the subject of Government inspection and recommendation (and in extreme cases even of prosecution) very recently. Why should an employer who confines his employees in a stuffy room be treated more severely than one who ruins their eyesight by grudging the necessary attention to lighting?

What may be pointed out in addition is that, even from the standpoint of the employer, it is folly to neglect this point. In the case of almost all skilled labour it is quite certain that the expense of bringing the lighting up to the standard is but a trifle in comparison with the amount that would be saved by the improvement both in quality and output of work; indeed, in many cases it is safe to say that such improvements as are needed would not really entail any greater running expenses, but only the exercise of a little forethought in using the light provided so as to help the workman instead of proving a nuisance to him.

But, in addition, there are obvious general grounds for dwelling on this point. Anyone who has been obliged to live for any length of time in dingy and badly lighted rooms knows the depressing effect of such surroundings.

Mr. Patchell, in his presidential address to the Association of the Engineers in Charge in 1908, remarked:—

"Good lighting is conducive to economy in both engine and boiler rooms, as plant in a badly lighted room never gets properly looked after or cleaned. Why should it? It is no credit to the cleaner if it cannot be seen. Dirt is about the worst disease a plant can suffer from, as it invariably means neglect of small indications and warnings, timely attention to which would prevent the otherwise inevitable break-down. Not only is the plant better cared for, but men all work better in cheerful surroundings, and lose less time through sickness."

Another point on which stress may be laid is that a very close connection undoubtedly exists between the number of accidents that occur in works, and the condition of the lighting. Naturally, it is easier for an employee to allow a limb to stray into machinery which, in a dingy ill-lighted room, is blurred and indistinct. In addition, the incorrect placing of light sources, and the resultant throwing of inconvenient shadows by tools is just as likely to be responsible for an error of judgment on the part of an operator engaged in a delicate piece of work.

At the present moment this matter is of particular interest in view of the Commission that has recently been appointed to consider causes of accidents in factories and workshops, and I should like to urge that no such inquiry can be considered complete that does not take into account the part doubtless played by defective illumination in causing accidents of this nature.

The report of the Chief Inspector of Factories for the year 1908 contains a number of pertinent comments on the effect of the lighting conditions on the health and well-being of operatives. It is gratifying to find one of the inspectors reporting that great advances have been made in the artificial lighting of factories; the same observer, however, remarks that the fact is not generally appreciated that the daylight-illumination requires corresponding care. A very striking case is that of laundries. It would seem fairly evident that where cleanliness is the great consideration, only the very best illumination can be deemed sufficient, and it is not surprising to find one of the inspectors, Miss

Patterson, drawing attention to the effect of "crowding machinery into ill-lighted corners."

But, perhaps, the most interesting comment is that of Miss Squire, who referred to the defective illumination in certain Yorkshire textile factories, and the results of the trying work in a poor light on the eyesight of employees. Sometimes the suggestions of the inspectors recommending were welcomed and acted upon. "Sometimes, however," she says, "we are met with indifference or reluctance to spend money on this condition for healthy working, *and we have no statutory provision to rely upon.*"

The need of more definite recommendations regarding illumination, therefore, is now beginning to be felt. Reference may, in this connection, be made to a very interesting report of the Conseil d'Hygiène de la Seine in Paris on the subject of factory-lighting. As a communication from a municipal body this forms a somewhat important precedent. The report contains abstracts from the regulations of the chief European countries.

While not proposing any immediate drastic regulations the report emphatically endorses the wisdom of keeping all bright lights out of the field of view of workers and also advises that walls should be light in tint and have good reflecting qualities. It is interesting to observe that the only country, apparently, that prescribes definite minimum illumination is Holland, where an intensity of 10 to 15 bougie-metres on the work is specified (1 to 1·5 foot-candles approximately).

Lighting of Hospitals, Libraries, Churches, Etc.

Under this heading I may include a number of miscellaneous cases of lighting, all of which are of very great importance, but which, unfortunately, would require a lecture to themselves if treated fully. I may first point out the obvious necessity of lighting a *hospital*, where people in an invalid and depressed condition are confined with special care.

It is scarcely necessary to point out that people, under such circumstances are specially susceptible to the effect of unsatisfactory conditions of illumination, and trifling defects in the lighting arrangements, which a healthy individual might ignore, assume much greater importance in the case of people who are seriously unwell and possibly feverish. Anything in the least inclined to suggest a glare is most objectionable, and flickering and unsteady lights are particularly undesirable. One may also point out that the lighting of a ward in a hospital where patients in a convalescent stage are confined is probably governed by conditions quite distinct in many respects from those that should prevail in a room in which patients are seriously ill.

The daylight illumination provided is perhaps of special consequence, stress being laid by many in the medical profession on the part often played by sunlight in promoting a patient's recovery. For instance, at the request of the Westminster Hospital, an interim injunction was recently granted restricting the height of the adjacent new Wesleyan Memorial Hall now being built by the trustees of the Wesleyan Twentieth Century Fund. It was contended by the medical authorities that the proposed plan would interfere with the access of light to one portion of the hospital, and that the recovery of patients would be appreciably retarded thereby.

The necessity of paying careful attention to the light in *libraries*, where people use their eyes very severely, must also be borne in mind. This last matter is the more urgent because the people who use libraries in the evening by artificial light are, as a rule, earnest students, the class of people who derive most benefit from libraries, and who, therefore, deserve the best artificial illumination that can be provided in order to facilitate their strenuous work.

Both libraries and hospitals frequently constitute an expense to the general public, who have a right to see that the best value is got for their money. The lighting of a number of such public buildings may in the aggregate amount to a considerable sum, and therefore it is only just that care should be taken not only to get efficient results, but also to exercise due economy.

A recently-issued report of the "Committee on Machinery and Engineering Staffs at Poor-law Institutions," which deals incidentally with the lighting conditions, well illustrates this point. The published figures for the lighting in question show remarkable variations, and the conclusion is drawn that greater care should be exercised in the control of the expenditure of gas and electricity than at present. Yet it must be recalled that many different varieties of buildings, which serve very distinct purposes, are grouped under this head, and it is, therefore, very difficult to draw any valid conclusion without knowing fuller details of the conditions in each case. One point may, however, be emphasised. It would

well repay the authorities in such cases to obtain the advice of a competent expert when the original lighting scheme of a new building is under consideration. Experts called in at a later stage may, indeed, be able to effect a considerable saving; yet, when once the installation is complete, any modification must be in the nature of a compromise, and it is rarely possible to secure as efficient results as might have followed the original adoption of a carefully thought-out plan.

In this connection I should like to mention the work of Mr. L. B. Marks, a well-known illuminating engineer in the United States, and the first President of the Illuminating Engineering Society, who has recently undertaken and described the lighting of the Carnegie libraries in New York, in a specially careful manner (*Illuminating Engineer*, Vol. I., 1908, page 921). Here, again, I should like to point out the inconsistency of paying for the collection of expensive books, sometimes unique and unreplaceable, housing them in costly buildings, and then providing a system of illumination that makes reading more than a weariness of the flesh.

And next, a few words may be said upon the lighting of churches and public buildings of architectural distinction. In such cases, economy and illuminating efficiency, in the technical sense, are often subservient to artistic effects. But once more we must remember that it is only through the eye, and through the illumination provided, whether daylight or artificial, that the interiors of such buildings are visible at all. Therefore it is surely worthy of consideration to scheme out the lighting very carefully, and to consider exactly what the sources used have or have not to do. This is a matter I commend to the study of architects, who are now coming to take a keener interest in questions of illumination.

Fig. 83.

Second Floor, Carnegie Library in New York. (L. B. Marks, Second Annual Convention of the Illuminating Engineering Society in the United States, 1908.)

The lighting of such national buildings as Westminster Abbey surely deserves very careful consideration indeed, and when we remember that they frequently fulfil several distinct purposes the choice of an effective method of illumination becomes correspondingly difficult. For instance, Westminster Abbey serves primarily as a religious building, but, being the treasury in which so many national monuments, &c., are stored, also partakes of the nature of a museum. And the lighting of our museums, if attempted artificially at all, surely demands the greatest care we can give it. For the exhibits can only make their appeal through the eye, and the eye only becomes aware of their

existence by the aid of light. Naturally therefore one would suppose that the method of lighting specimens so as to show off their chief points to the best advantage would be very carefully thought out and as near as possible ideal for the purpose; it is doubtful whether this can often be said to be the case.

Fixture Design.

This, again, is a very wide subject into which I cannot enter in detail. It will, however, be readily appreciated from what has been said already, that fixture-design offers great opportunities to the man who has not only a knowledge of the details of the best methods of distributing light efficiently, but also a genuine appreciation of artistic principles. There seems little doubt that a great many of the types of fixtures in general use at the present day leave something to be desired both from the æsthetic and practical standpoints, though great improvements have recently been made; in the United States in particular, the recent formation of the Illuminating Engineering Society has given a great impetus to the scientific design of fixtures from the standpoint of practical efficiency. It is, however, often interesting to observe the care which was bestowed on the artistic design of sources of illumination in the past, which were certainly very primitive regarded from the practical standpoint as illuminating apparatus, but were not infrequently distinctly effective as ornaments.

It is also hardly necessary to dwell upon the importance of a knowledge of the particular varieties of fittings which are best adapted for use in certain interiors; the illuminating engineer, engaged on such work, needs to possess a considerable knowledge of art and architecture in order to contrive arrangements in harmony with the existing scheme of decoration.

An interesting point has been raised in a recent number of *The Builder*. The author criticises many of the existing electric light standards in the streets of London, and points out how illuminating apparatus of this kind, while at night mainly essential for the purpose of producing light, ought to be decorative by day when its main function is in abeyance. The engineer would often be grateful for guidance on the æsthetic principles involved in this question. Certainly the style of lamp-posts lining a street can do much to make or mar its architectural appearance, and ought to be in harmony with the style of buildings or surroundings.

Fig. 84.

Roof Reading Room, Carnegie Library in New York. (L. B. Marks, Second Annual Convention of the Illuminating Engineering Society in the United States, 1908.)

STREET LIGHTING.

The subject of street lighting received some attention in Part III. of these lectures (see p. 805), but this occasion may be taken of emphasising a few of the most important points in connection with the matter. Since the delivery of these lectures the writer has had an opportunity of visiting many of the chief continental cities and conversing with the chief engineers responsible for the street lighting, both gas and electric, therein. Many differences of opinion were met with but it was invariably agreed that the points in dispute among experts could be largely cleared up if only the different authorities interested could be got together to discuss the matter and determine in what good street lighting really consists. At present the criteria are extremely vague, what is regarded as eminently satisfactory in one city being tabooed in another.

Unfortunately it cannot be said that any really adequate effort has yet been made to distinguish between the purely local conditions which so often influence decisions on this matter and the general principles which are applicable to most cities, It is frequently supposed by those who do not appreciate the part which local conditions inevitably play in deciding such questions that because some city, Berlin for example, adopts incandescent high-pressure gas lighting after protracted tests comparing the results of this method with those obtainable by electric lighting, therefore the relative merits of both methods have been settled once and for all and that any other town in doubt as to the method of lighting to be adopted can profit by their lesson and do likewise.

In reality the decision of the authorities may be mainly influenced by facts quite outside the tests in question. In Berlin, for example, the gas-plant is owned by the municipality while the electricity supply company pay handsomely for the privilege of undertaking electric lighting. Now vast extensions to the present gas-generating plant have recently been made at Tegel near Berlin, and the authorities must naturally look to street lighting as a main outlet for the gas generated. It may in fact be said that every city has to find out for itself which method of lighting best meets local conditions.

Yet there is no reason why they should not derive useful information from properly organised experiments of other cities relating to matters which really can be settled by scientific experiment. But these experiments must be undertaken with a clear and definite idea of what it is desired to find out, and the results derived from them must be presented in such a way as to be free from confusion with the local influences referred to. And in order to be reliable such tests ought to be undertaken by an impartial and expert authority whose decision would carry weight. The writer long ago advocated the establishment of a central testing department for the purpose of undertaking genuine research into street lighting problems. The tests would be more valuable, even on the present lines, where they undertaken by representatives of gas and electric lighting conjointly and on a pre-arranged common plan. At present, what frequently happens is that a series of tests are undertaken by an expert in electric lighting, and another series, undertaken on quite different assumptions and under quite different conditions by a representative of gas lighting. Subsequently the results (being really not strictly comparable) are found to be at variance, and those connected with each system profess to distrust the tests of the other and to believe that he has contrived a method of experiment which is specially favourable to his own illuminant. Were the experiments carried out by both representatives simultaneously, as explained above, much useless subsequent recrimination might be spared; and there would be more probability of our being able to draw some useful conclusions.

There is in some quarters an impression that street lighting is a simple matter which can be readily judged by ocular demonstration before a body of men having no technical knowledge of the matter. Apart from its other drawbacks, however, it is at least obvious that such methods must give rise to hopeless difference of opinion, and that the possibilities of such differences are accentuated by the fact that an opinion so based cannot be substantiated by reference to any record which would guarantee that the conditions existing when the impression was gained would be maintained subsequently. When our knowledge of the lighting in a street is based on photometric tests we can, at any subsequent period, repeat these tests in order to ascertain whether any change in the conditions has occurred. But when we merely depend on our recollection of what the lighting looked like on some past occasion, how is it possible to justify an impression that the light has deteriorated?

In addition, it is safe to say that ordinary people base their views on the lighting of a

street on very different data. Many people, for instance, will be found to judge far more by the apparent brightness of the sources themselves than by the available illumination which they shed upon the roads and pavement. Nor is it to be expected that a man who has not really studied the problem can, by a mere visual impression, unsupported by any means of measurement, determine which of two alternative systems of lighting is best fitted to suit the complex demands of traffic, the needs of pedestrians, artistic appearance, and the other factors which have to be duly weighed in this matter.

In short, we need to form more definite views regarding what the object of street lighting should be, and better methods of expressing and measuring the requisite conditions. For this purpose photometry, as we now know it, is admittedly capable of improvement, and may in the future be supplemented by other tests. But it is certainly capable of preserving a record and yielding much valuable information unobtainable at present by any other means.

Shopwindow Lighting.

A word or two may be said on this interesting subject. There is, perhaps, scarcely any field where the principles of illuminating engineering can be more profitably employed. It is no exaggeration to say that one still cannot walk the streets of London, or indeed any city, without constantly meeting examples of light, not only unwisely, but actually uselessly employed.

We have seen previously how the interposition of a bright light causes the pupil-aperture and retina of the eye to react in such a manner that objects of a darker hue in the background become difficult to see, and how the eye is injuriously affected by continual exposure to glaring lights. Yet one frequently sees naked filaments placed in the window between

Fig. 85.

Shop Window, Richmond, U.S.A. Lighted by Gas; Night View (Welsbach Co.).

the eye of the observer and the goods he is intended to observe by their light; frequently, too, the pedestrian is dazzled by a lavish use of intensely bright flame arc lamps, hung well within his field of vision round a shop-window; such lamps if not properly located are also a menace to traffic on account of their inconvenience to drivers. It is satisfactory to observe that regulations have recently been introduced in the City of London, forbidding the use of such lamps unscreened towards the roadway.

Such malpractices ignore the wise motto, "Light on the object, not in the eye." To be successful, any method of shopwindow lighting must be at least comfortable to the eyes. A window may well be likened to a miniature stage. The use of bright lights has been defended on the ground that it is necessary to be lavish in this respect to attract custom. Excessive glare may, indeed, attract the eye involuntarily, but it is questionable whether anything is gained thereby, as the observer naturally tends to avert his gaze from anything actually distressing.

The most successful methods of shop lighting seem to be those in which the lessons of the stage are taken to heart, abundant light being shed upon the goods while the actual sources themselves are screened from the eye of the observer. Some examples of this method are shown in Figs. 85 and 86.

In Fig. 86 it will be observed that the same lights which, concealed, illuminate the contents of the window, are also utilised to illuminate the sign "Cigars"; this is a device which is now becoming very popular.

Fig. 86.

Tobacco Shop in Washington, U.S.A, Lighted by Gas. Night View.

In Fig. 88 will be seen a means of applying this method by the aid of flame arc lamps, which are placed above a diffusing glass surface over the goods, and can be drawn aside to be attended to, when necessary, as shown in the illustration.

Apart from these obvious rules of good lighting there are, of course, endless possibilities in the direction of achieving special effects by the use of light, and these afford great scope for artistic treatment. In some of the best shops arrangements are made enabling several alternate methods of lighting to be used, a change in the contents of the window

being accompanied by a change to the method of illumination best adapted to display them to the best advantage.

In this connection it may be of interest to point out that a change in the motives of window-display, first perceived in the United States, seems to have been making itself felt perhaps especially in the United States, it is becoming felt a tasteful shop-window should be mainly devoted to novel and specially interesting goods, so that the passers-by may come to regard its contents, not as a catalogue, but as a summary of the most recent developments; this leads him to look to the window

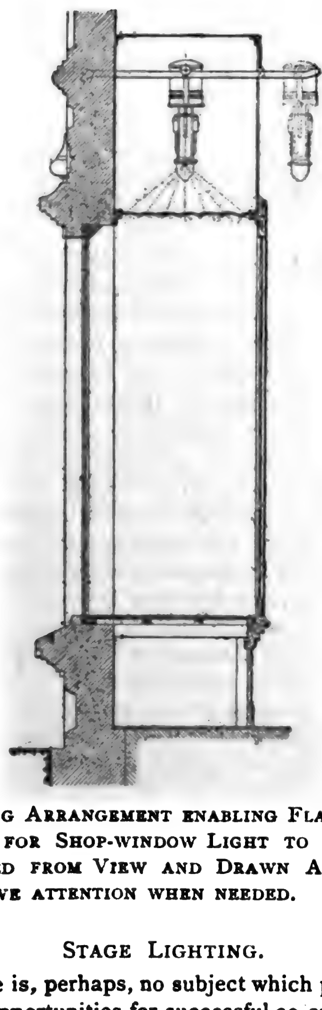
FIG. 87.

SHOP WINDOW OF CARPET STORE ILLUMINATED BY MEANS OF REFLEX GASLIGHTS. (Welsbach Co.)

also in this country of late. In many shops the window display is regarded mainly as an inventory, as complete as possible, of the goods kept in stock. The customer is expected to make up his mind what he wants by inspection of the window, enter, and ask for this article. This naturally involves crowding the windows and makes effective lighting methods difficult to achieve. Now, however, for novelties and not to pass it by, assuming by the force of habit that it contained nothing new. He would, therefore, no longer be expected to make up his mind as to his requirements before entering, but would be induced to do so whilst yet undecided as to whether he meant to purchase, and would be prepared to entertain suggestions and assistance from the shopman on the subject of what he needs. It

is possible that this newer attitude towards window-dressing may have a beneficial influence on the methods of lighting employed.

FIG. 88.



SHOWING ARRANGEMENT ENABLING FLAME ARC USED FOR SHOP-WINDOW LIGHT TO BE CONCEALED FROM VIEW AND DRAWN ASIDE TO RECEIVE ATTENTION WHEN NEEDED.

STAGE LIGHTING.

There is, perhaps, no subject which presents better opportunities for successful co-operation between the illuminating engineer, with a knowledge of the best means of producing and using light, and the artist with his trained perception of what is most beautiful, than that of stage lighting.

It is not only that the general method of illumination employed in a theatre is of very vital importance; in any entertainment in which an appeal is made to the eye it is, of course, essential that there should be nothing distressing or distracting in the illumination provided for the benefit of the audience. But the success of many theatrical pieces and operas is so closely connected with the impression received through the eyes, that the illumination of the stage itself must require not only specialised knowledge of technical details, but also, in an exceptional degree, fine perceptions and artistic sensibility. In operas, for instance, one can readily understand that the scheme of lighting should produce an effect parallel to and in harmony with that produced by the music. The most artistic scenery, again, would be diminished in effectiveness by a choice of a method of lighting which interfered with the proper colour relations. There are also numberless theatrical devices, such as the simulation of flowing molten metal, the production of sparks between clashing swords, apparitions, and so forth which offer great scope to the ingenuity of the engineer in charge of the lighting of the stage.

While it may be justly said that the arrangements at our best theatres often reflect very great credit on those responsible for the stage lighting arrangements, it seems quite reasonable to suppose that in this subject special benefit might follow a closer co-operation between the illuminating engineer, the artist, and the other specialists whose views have a more or less direct bearing on the subject.

LIGHTHOUSE ILLUMINATION, &c.

The provision of proper means of illumination round sea coasts, for the indication of waterways and channels, and for purposes of navigation generally, is, of course, a matter of international importance, and one on which the concerted action of different nations is particularly to be desired. The wideness of the subject, which demands peculiar expert knowledge, is well illustrated by the annual report issued by the Lighthouse Board of the United States.

I cannot discuss this important subject in any detail on this occasion. It may, however, be said that it is one which the illuminating engineer should find of special interest, and in connection with which he may, in the future, render valuable service, because it involves the consideration of the merits of the different illuminants in an impartial manner.

Those who wish for fuller information may be recommended to study the report of the Royal Commission, which was issued last year, relating to the lighting of the shores of Great Britain and Ireland.

SOME PHYSIOLOGICAL EFFECTS OF DIFFERENT QUALITIES OF LIGHT.

I may next make a few remarks upon another feature of artificial lights of the

present day which seem to require study. I have already drawn your attention to the difference in the colour of light yielded by modern sources. Now we have no precedent to enable us to determine what may be the effect of very peculiar coloured light in any quantity on the eye, though there is scientific work on record which suggests that visible light from different parts of the spectrum produces diverse physiological effects. Therefore one would certainly recommend that we should be cautious in seeking to work for long hours under any peculiar variety of light. Professor Burch, in the work previously referred to, has dwelt upon the disturbances of colour vision which may be called into play through intense stimulation of the eye by monochromatic light, and it is therefore legitimate to suggest that prolonged working under light of one colour might eventually affect the eyes in some such way.

Meantime it is interesting to observe that there seems to exist some prejudice in favour of light of a more or less golden colour as compared with the whiter tinge of the most recent illuminants. The explanation of this preference offers very debatable ground for discussion. Some authorities have maintained that light from the red end of the spectrum has an actual stimulating physiological effect, while blue and green light, on the other hand, are depressing. Others have sought to show that a preference for yellowish light is merely a matter of association. From the early camp fires onwards our sources of light and heat have come to be associated with red and yellow shades of colour, and we involuntarily connect this view with the warmth and brightness within as opposed to the blue shades of twilight and the coldness without.

It seems quite conceivable that the radiation from the different portions of the spectrum, which we are accustomed to consider mainly in connection with its illuminating capacity, may also be responsible for deep-seated physiological effects and influence our health and well-being to a very considerable extent. And, leaving out of account for the moment the possible special effects of visible light of different colours, we must also remember that our present illuminants radiate a wide range of invisible waves, which are not detected by our eyes as light but which may, nevertheless, not be without influence upon our physiological condition. Recently a number of facts have been discovered about the behaviour of the so-called actinic or ultra-violet rays (beyond the violet in the visible spectrum), which have led physiologists and physicists to attach some importance to their presence, to some extent, in all illuminants. With this matter we shall deal in some detail later.

For the moment, however, let us turn our attention to what is known regarding the quality of radiation from different illuminants, and the manner in which the energy is distributed throughout the visible and invisible spectrum. This quality, we shall find, exerts a very material influence on the efficiency of light-production of the different sources.

The Distribution of Energy in the Spectra of Illuminants and the Efficiency of Light-Production.

In what follows, therefore, I wish to proceed to consider some of the scientific theories of light production. It has long been believed that the majority of sources of light, considered from the scientific standpoint, are hopelessly inefficient, producing but a small fraction of the energy supplied to them in the form of light. For instance, the percentage of the energy developed by electric glow-lamps in a visible form has been variously stated as being only about from 1 to 10 per cent., all the rest being produced as heat or other forms of energy which are non-luminous.

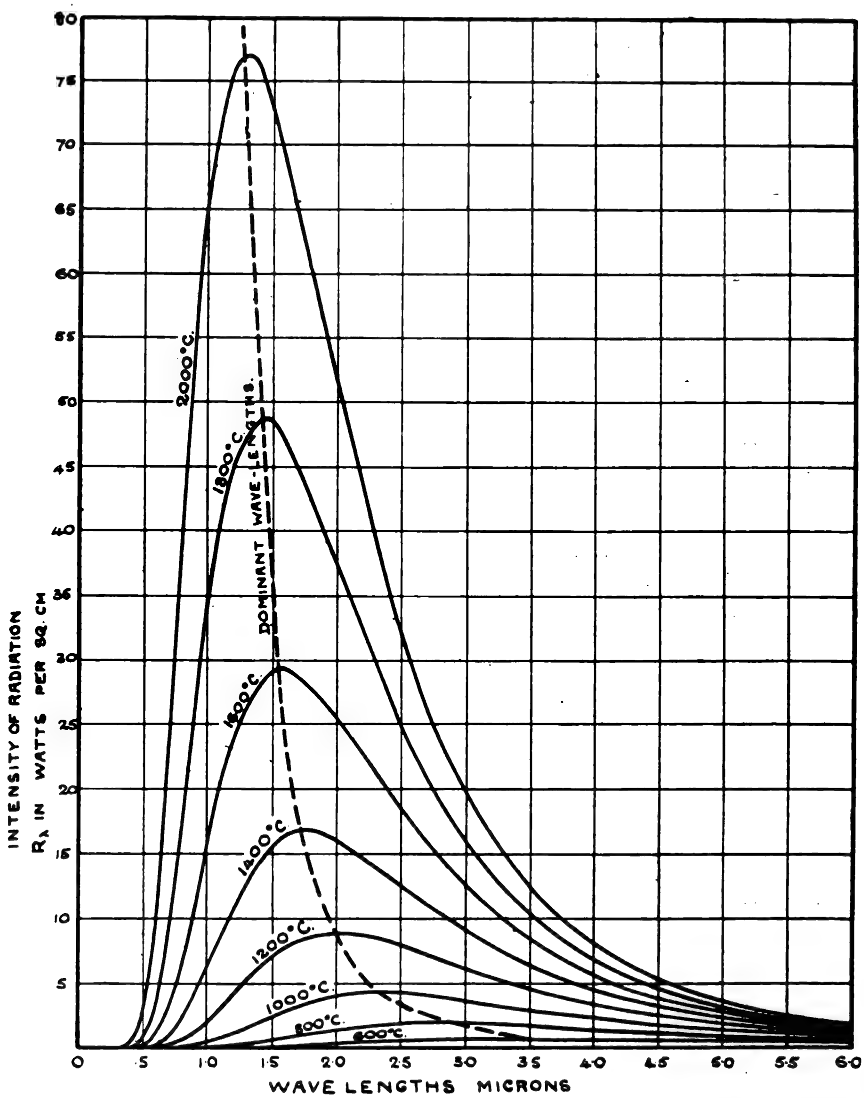
As explained in my first lecture, the majority of our illuminants consist of incandescent solids. We merely heat up a solid body until, amid the jumble of vibrations that occur, we find a few sufficiently rapid to emit light. One interesting quality of incandescent solids is illustrated by Kirchoff's law, which states that every body emits only that radiation which it can absorb. According to this view a *truly black body*, which absorbs all the energy falling upon it, can naturally emit all forms of energy. Most of our incandescent solids resemble a black body somewhat closely, and therefore the curves describing the quality of radiation obtained from such bodies at different temperatures, according to Lummer and Pringsheim, are of considerable interest. Fig. 89, which is taken from a recent article by Dr. Drysdale in the *Illuminating Engineer*, shows these curves. I cannot, on this occasion, enter into the methods by the aid of which the energy in any part of the spectrum can be measured. Most of these methods depend upon the reception and absorption of such energy upon a blackened surface; the rise in temperature of this surface may be taken as a measure of the energy impinging upon it and

Luminous Efficiencies of Various Sources (Drysdale, the *Illuminating Engineer*, June, 1908).

Source.	Observer.	Date.	Method.	Total Efficiency. Per cent.	Radiant Efficiency. Per cent.
Candle	Thomsen	1863	A	0·3	2·1
Oil Flame	Melloni	1833	A		10
	Thomsen	1863	A		2·06 to 2·11
	Wedding	1905	A		0·029
	Lux	1907	A	0·25	1·23
Hefner Lamp	Lux	1907	A	0·103	0·89
Gas flame	Tyndall	1862	A		4
	Thomsen	1863	A		1·84 to 2·11
Incandescent Gas	Lux	1907	A	0·46 to 0·51	2·03 to 2·97
Acetylene Flame	Angstrom	1902	A		5·6
	Nichols and Coblentz	1903	C		3·3 to 4
	G. W. Stewart	1902	C		4
	Lux	1907	A	0·65	6·36
Glow Lamp					
Incandescent	Melloni	1833	A		2
Platinum	Tyndall	1862	A		4·17
Carbon Filament	Merritt	1889	B	·5 to 7·2	
	Russner	1907	B	·58 to ·61	
	Wedding	1905	A		0·34
	Lux	1907	A	2·07	2·7 to 3·2
Nernst	Ingersoll	1903	C		4·7 falling to 3·6
	Wedding	1905	A		0·85
	Lux	1907	A	3·85 to 4·21	5·7
Tantalum	Russner	1907	B	2·2	
	Lux	1907	A	4·87	8·5
Osmium	Russner	1907	B	2·3	
	Wedding	1905	A		0·62
Osram	Russner	1907	B	2·46	
	Lux	1907	A	5·36	9·1
Arc Lamp	Tyndall	1862	A		10 to 11
	Tyndall	1862	C		7·7
	Nakano	1889	A		1·48 to 8·1 various angles.
	Marks	..	..		2·3 to 16·2
	Wedding	1905	A		0·318
D.C. Arc	Lux	1907	A	5·6	8·1
D.C. enclosed Arc	Lux	1907	A	1·16	2·0
Flame Arc, yellow	Lux	1907	A	13·20	15·7
Flame Arc, white	Lux	1907	A	6·66	7·6
A.C. Arc	Lux	1907	A	1·9	3·7
Mercury Arc	Geer	1903	A		40 8 to 47·9
Uviol Mercury, Vapour	Lux	1907	A	2·24	5·8
Quartz Lamp	Lux	1907	A	6·00	17·6
Vacuum Tube	Drew	1903	A		23·4 to 48·6

is recorded by suitable means, usually thermo-electric. You will, however, see that as the temperature increases the percentage of the radiation lying within the visible spectrum increases also very markedly, and hence our efficiency increases; Dr. Drysdale has recently calculated that the luminous efficiency even of an incandescent black body might attain 50 per cent. at the enormous temperature of 7,000°. Naturally, we can hardly hope to pproach this temperature in any of our ordinary illuminants, and, therefore, the efficiency as a light-producer is usually very low. The curves in Fig. 90, for instance, show the distribution of radiation in the case of a flame, the arc light, and the sun, as determined by the American physicist, Dr. S. P. Langley, and recently presented by Dr. Drysdale in the articles referred to above. Only in the case of the sun does the maximum fall within the visible spectrum; the majority of energy even then is waste, as far as luminous impression

FIG. 89.

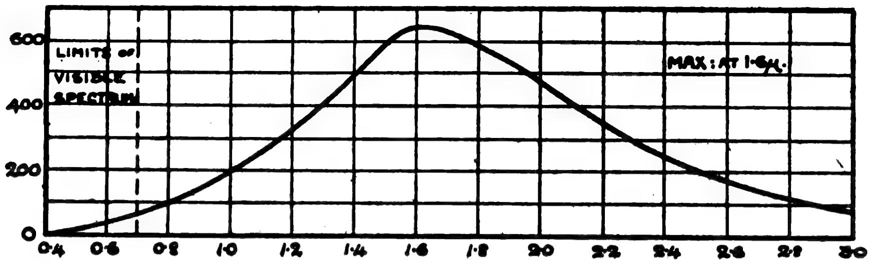


CURVES OF RADIATION FOR BLOCK BODY.
(*See* Drysdale, *Illuminating Engineer*, London, Vol. II., 1909, p. 231.)

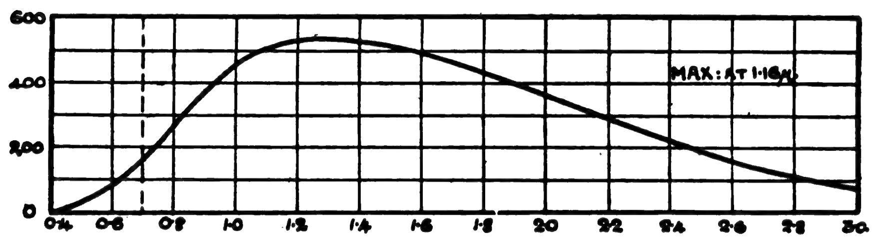
is concerned. It will, however, be perceived that in the case of the firefly a very different condition of things occurs, all the energy being concentrated within the visible range.

The mention of phosphorescence leads me to speak of an alternative method of increasing efficiency besides increasing the temperature of a body. Instead of employing the confused

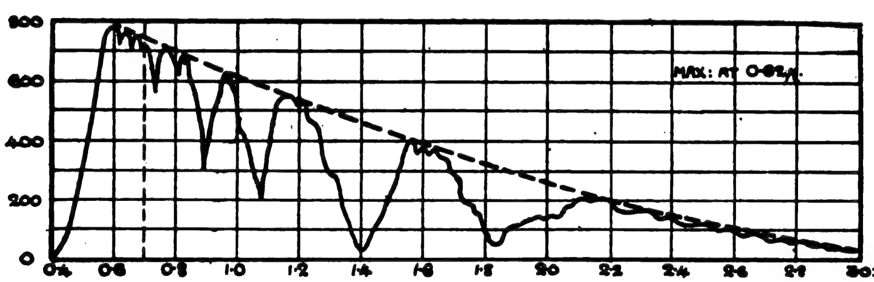
FIG. 90.



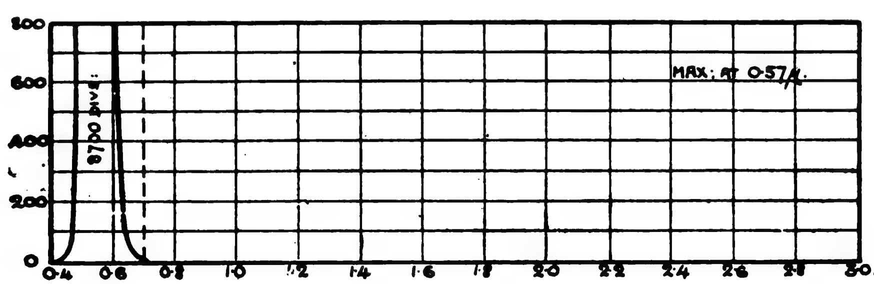
Energy Distribution in Flame Spectrum.



Energy Distribution in Arc Spectrum.



Energy Distribution in Solar Spectrum.



Energy Distribution in Firefly Spectrum.

LANGLEY'S CURVES OF RADIATION. (Drysdale, *Illuminating Engineer*, London, Vol. II., Jan. 1909.)

This has been suggested by some observers to be a curious property of fluorescent and phosphorescent substances, and leads us to hope that a really efficient light might be produced by this means in the future.

vibration of an incandescent solid, in which the whole mass vibrates as a whole, we may employ the free natural vibrations of a phosphorescent or "luminescent" substance.

Theoretically, as we have seen, it might be

considered with some reason that the ideal illuminant would be one which produced a curve of spectral intensity identical with that of average daylight, but entirely confined to the visible range of vibration. Could we, therefore, discover a substance the natural vibration of which corresponded exactly to this state of things we should consider ourselves on the way towards solving our problem. Even the above assumption, however, may perhaps ultimately be found to require modification.

From one point of view an illuminant which produces all the rays just as they exist in the visible spectrum of daylight, and these only, might be said to have an efficiency of 100 per cent. But since the luminous efficiency of different parts of the spectrum itself differs very much, the maximum effect being, according to some authorities, produced in the yellow-green, it might be possible, by sacrificing colour, to receive yet greater efficiency. For certain purposes, in a lighthouse, for instance, it is obvious that correct colour appearance is immaterial; *brightness* is what we chiefly want. Therefore one might recommend the attempt thus to specialise in the most efficient light for certain special purposes.

Yet even this recommendation wants modification, because it is evident that all such statements are affected by the physiological peculiarities of the eye. Without entering further into this question it may be said that according to some authorities the behaviour of the eye seems to be profoundly altered when the illumination is very low; therefore the light, which is most efficient under ordinary circumstances, may not be the most serviceable under these altered conditions.

Many investigators have sought to determine what would be the theoretical efficiency possible in the case of an approximately white light, supposing that we were able to exclude all the wasteful non-luminous radiation and to produce only luminons energy. According to Dr. C. V. Drysdale, for instance ("Proc. Roy. Soc.," Vol. 80, 1907), it should be possible theoretically to obtain a white source running at only 0·08 watts per candle, and a monochromatic yellow-green source consuming only 0·0598 watts per candle. This, of course, would be a great advance on the best of our present metallic filament electric lamps which probably cannot, as yet, be commercially used at less than about 1 watt per candle.

Yet it must be said that different observers have obtained very divergent numerical results on this question as yet. The theoretical efficiencies possible, on the assumption that only light energy is produced, according to Lux, Wedding, and others, are widely different, in many cases, from the figures mentioned above; we should probably act wisely in postponing judgment on this point until more complete data are available. Very possibly these values will be found to be largely dependent on the physiological conditions of the eye. For instance, Mr. J. S. Dow has suggested that, on account of the physiological phenomena alluded to above, the values of the maximum efficiency, for light of different colours, may be found to be very different at high and low illuminations, and may also be affected by the region of the retina in the eye used in making the determinations (*Electrical World*, N.Y., Dec. 12th, 1908).

Unfortunately, most luminescent substances at present display inclinations to radiate in an irregular manner, and to produce light of certain wave lengths only; thus a source like the mercury vapour lamp, or the flame arc, usually radiates very strongly in certain parts of the spectrum, while other portions are correspondingly weak. In the mercury light, for example, the red rays are entirely absent. Many flame arcs again owe their efficiency partly to the production of a very strong peak in the yellow, where the sensitiveness of the eye to visible light is believed to be a maximum.

Naturally, such sources as these cause considerable colour distortion in the coloured materials on which they impinge; even sources, however, which yield a continuous spectrum, differ very much in the strength of the radiation in different parts, and therefore differ in the appearance of coloured objects to which they give rise.

The Table obtained by G. H. Stickney (Illum. Eng. Soc. 1908) illustrates the appearance of objects of various colours seen under the light of various illuminants.

It may be suggested that a Table of this kind might well be of considerable interest to decorators, architects, and others engaged in problems connected with colour-effects in interiors. As was pointed out in Part V., the choice of the colour of wall-papers, &c., in an interior is a matter which has a very considerable effect upon the conditions of illumination, and should not be settled quite apart from the spectrum of the illuminant to be used. It is also not so easy invariably to foretell how an object of some particular shade may appear

when viewed by means of a different illuminant from that under which it is first seen and purchased; and, as mentioned previously, even the surroundings are not without influence in determining the colour of objects seen in an interior.

There is also a need for some form of instrument which can readily be applied to compare the spectra of different illuminants, and in this connection the "Ives colorimeter," which was described at the second annual convention of the Illuminating Engineering Society in the United States last year, is of considerable interest.

COLOUR VALUES OF ARTIFICIAL ILLUMINANTS.—By G. H. Stickney.
"Transactions" of the Illuminating Engineering Society (American), May, 1907, p. 282.

The Effect of Coloured Lights on Aniline Dyed Materials.
From Tests by M. Chevreul at the Gobelin Tapestry Works. With Additions by W. D'A. Ryan.

Orange	rays	falling on	white	make it	appear	orange.
,,	,,	,,	red	,,	,,	reddish-orange.
,,	,,	,,	orange	,,	,,	deeper orange.
,,	,,	,,	yellow	,,	,,	orange-yellow.
,,	,,	,,	green	,,	,,	dark yellow-green.
,,	,,	,,	blue	,,	,,	dark reddish-grey.
,,	,,	,,	violet	,,	,,	dark purplish-grey.
,,	,,	,,	black	,,	,,	brownish-black.
Red	,,	,,	white	,,	,,	red
,,	,,	,,	red	,,	,,	deeper red
,,	,,	,,	orange	,,	,,	orange-red.
,,	,,	,,	yellow	,,	,,	orange.
,,	,,	,,	green	,,	,,	yellowish-grey.
,,	,,	,,	blue	,,	,,	violet.
,,	,,	,,	violet	,,	,,	purple.
,,	,,	,,	black	,,	,,	rusty-black.
Yellow	,,	,,	white	,,	,,	yellow.
,,	,,	,,	red	,,	,,	orange-brown.
,,	,,	,,	orange	,,	,,	orange-yellow.
,,	,,	,,	yellow	,,	,,	deeper yellow.
,,	,,	,,	green	,,	,,	yellowish-green.
,,	,,	,,	blue	,,	,,	slaty-grey.
,,	,,	,,	violet	,,	,,	purplish-grey.
,,	,,	,,	black	,,	,,	olive-black.
Green	,,	,,	white	,,	,,	green.
,,	,,	,,	red	,,	,,	yellowish-brown.
,,	,,	,,	orange	,,	,,	greyish-leaf-green.
,,	,,	,,	yellow	,,	,,	yellowish-green.
,,	,,	,,	green	,,	,,	deeper-green.
,,	,,	,,	blue	,,	,,	bluish-green.
,,	,,	,,	violet	,,	,,	bluish-grey.
,,	,,	,,	black	,,	,,	dark greenish-grey.
Blue	,,	,,	white	,,	,,	blue.
,,	,,	,,	red	,,	,,	purple.
,,	,,	,,	orange	,,	,,	plum-brown.
,,	,,	,,	yellow	,,	,,	yellowish-grey.
,,	,,	,,	green	,,	,,	bluish-green.
	,,	,,	blue	,,	,,	deeper-blue.
,,	,,	,,	violet	,,	,,	deep bluish-violet.
,,	,,	,,	black	,,	,,	bluish-black.
Violet	,,	,,	white	,,	,,	violet.
,,	,,	,,	red	,,	,,	purple.
,,	,,	,,	orange	,,	,,	reddish-grey.
,,	,,	,,	yellow	,,	,,	purplish-grey.
,,	,,	,,	green	,,	,,	bluish-grey.
,,	,,	,,	blue	,,	,,	bluish-violet.
,,	,,	,,	violet	,,	,,	deeper-violet.
,,	,,	,,	black	,,	,,	violet-black.

PREDOMINATING COLOUR OF ARTIFICIAL LIGHTS.

Lamp.	Colour.
Enclosed arc—clear globes	Bluish-white.
Enclosed arc—opal globe and selective diffuser	White.
$3\frac{1}{2}$ amp. 140 volt d.c. enc. arc.	Violet (beyond colour correction).
Nernst lamp—new glower	Pale lemon-yellow.
Nernst lamp—seasoned glower	Deep lemon-yellow.
Incandescent—new	Yellow.
Incandescent—seasoned	Pale orange-yellow.
Welsbach and vapour hydrocarbon—new	Greenish-white.
Welsbach and vapour hydrocarbon—seasoned	Greenish-yellow.
Ordinary gas flame	Reddish-yellow.
Mercury arc lamp	Blue-green.

ULTRA-VIOLET LIGHT AND THE PHYSIOLOGICAL EFFECTS PRODUCED BY IT.

Apart from the effect of visible light, however—and it has been shown that artificial illuminants differ very markedly in this respect—the distribution of energy in the spectrum of illuminants varies yet more greatly, as the curve exhibited in Fig. 90 very clearly illustrates. Therefore we are naturally inclined to wonder what effect, if any, such changes in the character of the light we live under might have upon us.

This leads me to speak of a very interesting question that has recently been the subject of much discussion, namely, the effect on sight of the invisible rays of very short wave length beyond the violet in the spectrum of artificial illuminants. We have seen how, as the temperature of an incandescent solid body increases, the maximum of the curve of radiation is shifted forward towards the blue in the spectrum, so that the percentage of ultra-violet energy is distinctly increased. Now these rays appear to exert very marked physiological and chemical actions, and it has therefore been the subject of consideration how far the tendency towards accentuating them might be injurious.

Apart from this tendency of a part of incandescent solid substances, we have now at our disposal sources such as some types of arc lamps, and the quartz tube mercury vapour lamp, which are particularly rich in such radiation, and are, therefore, claimed to be specially serviceable for particular purposes, such as the destruction of bacteria, the treatment of leather, and for photographic and medical purposes. One very interesting example of the use of the Uviol lamp I may mention in passing. It is now believed that the fading of colours is largely due to the effect of ultra-violet light and the chemical action of rays of short wave length in the spectrum of the sun. Carpet manufacturers in the north of Germany used formerly to have to send their goods down south, where sunshine was more abundant, in order to test the permanence of their colours. Now, however, that a source so rich in ultra-violet light is available, they can test goods by the light of this lamp in a mere fraction of the time which was formerly necessary, and independently of climatic conditions.

The percentage of ultra-violet energy in ordinary incandescent illuminating agents is believed to be relatively small, possibly not more than a fraction of a per cent., but, on the other hand, it has been suggested that as much as 30 per cent. of the total energy radiated from the mercury quartz tube lamp is available in this form. Naturally, therefore, special precautions have to be taken to avoid such sources having an injurious action on the eyes of anyone using them.

That a small change in the quality of radiation may eventually cause the eyes inconvenience is shown by the experiences of travellers in the snowy regions and at high altitudes where the atmosphere is not sufficiently dense to absorb the ultra-violet rays in daylight so effectively as on the horizon. Snow blindness, and the tanning of the skin are well-known symptoms at high altitudes, which many observers have attributed to the effect of ultra-violet rays.

A considerable amount of work has been done on this subject by Drs. Schanz and Stockhausen, in Germany. These observers have suggested that artificial light is invariably more wearisome to the eye than daylight, and regard the tendency towards accentuating the ultra-violet in ordinary illuminants as undesirable. In support of their contention these workers have quoted the results of Widmarck and others, who found that by concentrating ultra-violet light on the eye-lens a turbidity was set up, and the lens

subsequently became semi-opaque. It has even been suggested that cataract is at least partially due to the action of these rays, and the well-known predominance of this defect among glass workers has been ascribed by some to the rays given out by the glowing material. This is now being made the subject of investigation by a special commission of the Royal Society appointed for the purpose. (See Dr. H. T. Parsons, "The Deleterious Effects of Bright Light on the Eyes," *Science Progress*, July, 1909).

Drs. Schanz and Stockhausen have studied the effect of different ranges of ultra-violet light, dividing them into three classes, as shown in the following Table :—

in most of the most recent illuminants. Ordinary glass, it will be observed, cuts off the extreme ultra-violet rays, but yet allows those which Drs. Schanz and Stockhausen consider to be the most dangerous to pass.

I will next perform a few simple experiments illustrating these points. The spectrum of an arc light is thrown upon the screen, the usual gradation of visible energy from red to violet being clearly discernible. But if now I introduce a screen made of barium platino-cyanide into the invisible portion of the spectrum out beyond the ultra violet, the existence of these rays is made evident by vivid green fluorescence. We now see the spectrum extending far beyond the usual violet limit, but these

Action of Ultra-Violet upon the Eye.

I.	II.	III.	IV.
760-400 $\mu\mu$.	400-350 $\mu\mu$.	350-300 $\mu\mu$.	300-0 $\mu\mu$.
Visible Rays.	Ultra-Violet Rays.	Ultra-Violet Rays.	Ultra-Violet Rays.
Reach the retina unaltered in character.	Cause the lens to fluoresce a lavender-grey, reach the retina, and are visible if the lens is removed, or if the visible region of the spectrum is suppressed.	Penetrate the eye, but do not reach the retina. Also absorbed by the eye-lens.	Do not penetrate, but cause inflammation of the outer eye.

They point out further that ordinary glass absorbs the rays from 0·5 μ onwards, but allows those between 0·4 μ and this value, to be transmitted unchecked, and have further devised a special variety of glass—which they term "Euphos"—for the purpose of absorbing these defective rays. Some samples of this glass, by the kindness of the inventors, I am able to show to-night, I believe, for the first time in England. Here, for instance, are a few specimens of chimneys and lamp bulbs made of the glass. For this glass, the authors claim that, although the ultra-violet radiation is so effectively absorbed, only a small proportion of the visible radiation is lost.

Fig. 91, 92, and 93, which exhibit some spectrographs of illuminants illustrating the behaviour of the glass, do not require much explanation. It will be seen that the effect of the introduction of the Euphos glass is to cut off the ultra-violet light sharply, but to allow the visible light to pass, even up to the violet, with comparative ease. The various spectra also make it clear that the presence of an appreciable ultra-violet element is to be traced

remote rays can only be made visible by the aid of some such fluorescent material. In the beam of light striking the prism and giving rise to the spectrum, I now introduce a slab of blue Uviol glass. This glass has the property of stopping nearly all but the violet and ultra-violet rays. The violet is now the only portion of the visible spectrum which can be even imperfectly seen, but the introduction of the sensitive screen or a block of Uranium glass gives rise to the characteristic green fluorescence.

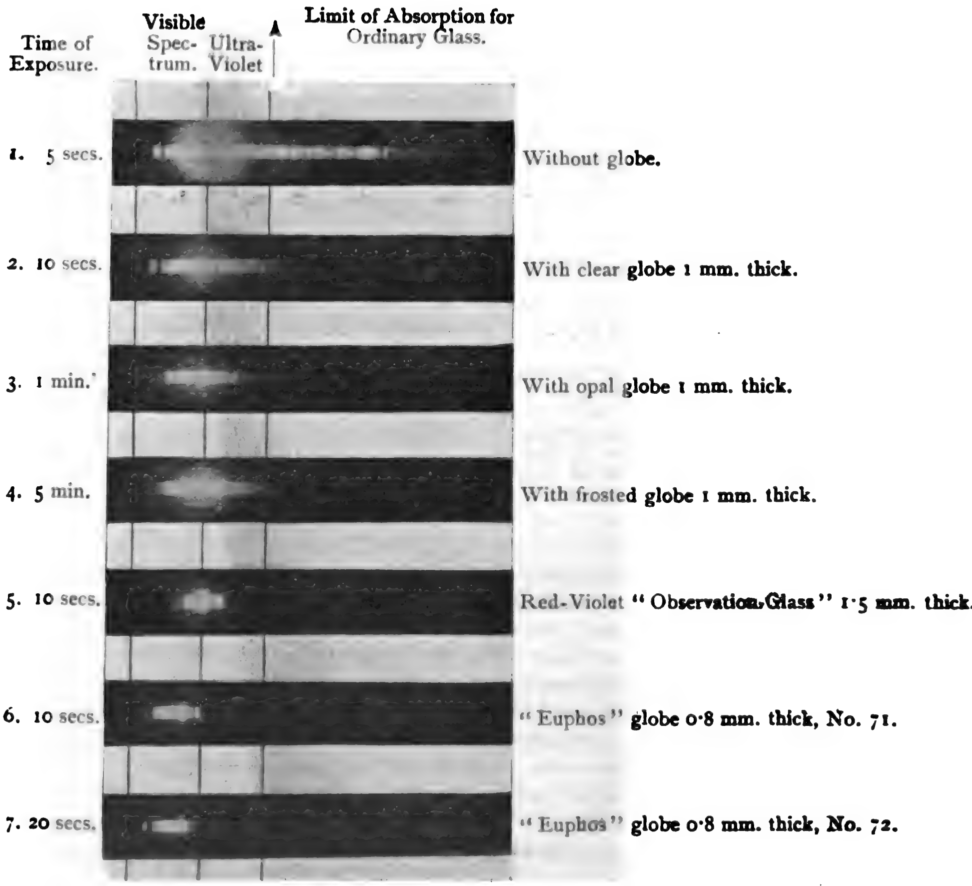
But if I now insert a sheet of the Euphos glass, which you will observe is practically transparent to visible light, in front of the beam, the fluorescence disappears, indicating that the ultra-violet rays have been checked. A piece of ordinary blue window glass, on the other hand, behaves in an exactly opposite manner. That is to say, when introduced in the path of visible light it throws a very dark shadow. Placed in the path of ultra-violet light, on the other hand, it gives rise to practically no shadow at all. In the same way, electric lamp bulbs and chimneys composed of

ordinary glass appear highly transparent to ultra-violet rays, and do not throw any distinct shadow on the fluorescent screen, while those composed of the Euphos glass appear very opaque, and give rise to a sharply-defined shadow.

I have dwelt at some length upon this question, not because I wish to over-emphasise its importance, but because it is typical of that no definite conclusions can be laid down as yet.

Among those who have differed from the two authorities referred to, I may mention Dr. W. Voege, of Hamburg, who has contributed several interesting communications to the *Illuminating Engineer*, stating his own view of the question (Vol. I., p. 775; Vol. II., p. 205).

FIG. 91.



ELECTRIC ARC LAMP, VISIBLE AND ULTRA-VIOLET SPECTRUM AND EFFECT OF EUPHOS GLASS.

many that will crop up in the future, and is one that can only be effectively solved by co-operation between the physicists and the physiologists. In this respect, whatever opinions we may hold as to the validity of their conclusions, the researches of Drs. Schanz and Stockhausen seem to be particularly worthy of imitation. Before leaving the subject, however, it is only fair to say that this matter is still the subject of investigation, and

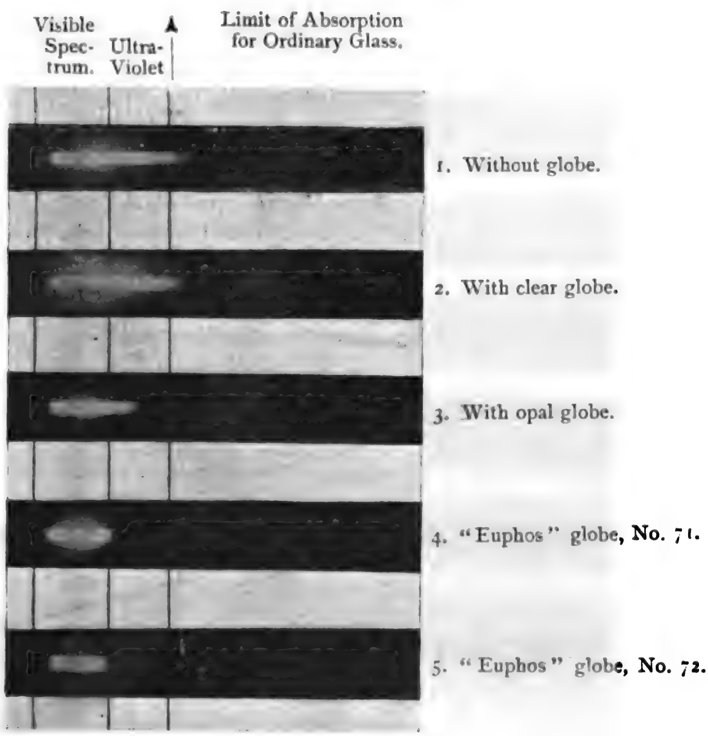
I have made special reference to this subject simply with the object, as I say, of showing how the effective co-operation between physicists and the physiologists may lead to very valuable results. As an illustration, however, that I am not alone in wishing to draw attention to the matter, I may mention that this very question formed the subject of a most animated discussion before the German Institution of Electrical Engineers, at their

annual meeting at Erfurt last year, and I think it is a remarkable recognition of the importance of these physiological questions that a purely engineering society should devote so much time to the subject. In addition, I may mention that the researches of Drs. Schanz and Stockhausen were communicated at the annual meetings of "oculists and others interested in physiological and natural science," (a very important body in Germany), in 1907 and 1908, and this too was an important recognition by the physiological authorities.

Whatever opinion we may hold as to the desirability or need of limiting the ultra-violet constituent in artificial illuminants, used under practical conditions, it will be conceded that when the eyes are exposed to exceptionally powerful doses of ultra-violet energy—in the study of arc-phenomena for example—some means of checking these rays effectually is very desirable. In this connection I might again refer to the work of Dr. W. Voege, who recently published an account of some interesting and useful researches on special spectacles intended to be used in this connection ("Elektrotechnische Zeitschrift," June 3rd, *Illuminating Engineer*, London, August, 1909). Dr. W. Voege finds that deep red glass is specially useful in this connection, when the loss of visible light so caused is of little consequence.

A somewhat interesting case of the injuries which may apparently result from incautious exposure to ultra-violet radiation is furnished by some recent experiences of Dr. Bellile in the French Navy. (*Illuminating Engineer*, London, April, 1909.) This observer records the experiences of some wireless telegraphy operators on certain French battleships who suffered trouble from the eyes which was considered to be due to the ultra-violet light given out by the spark used in connection with the transmitting apparatus. However, as Dr. Voege has pointed out, further data are certainly necessary in order to determine more exactly the part played by the ultra-violet constituent in light

FIG. 92.



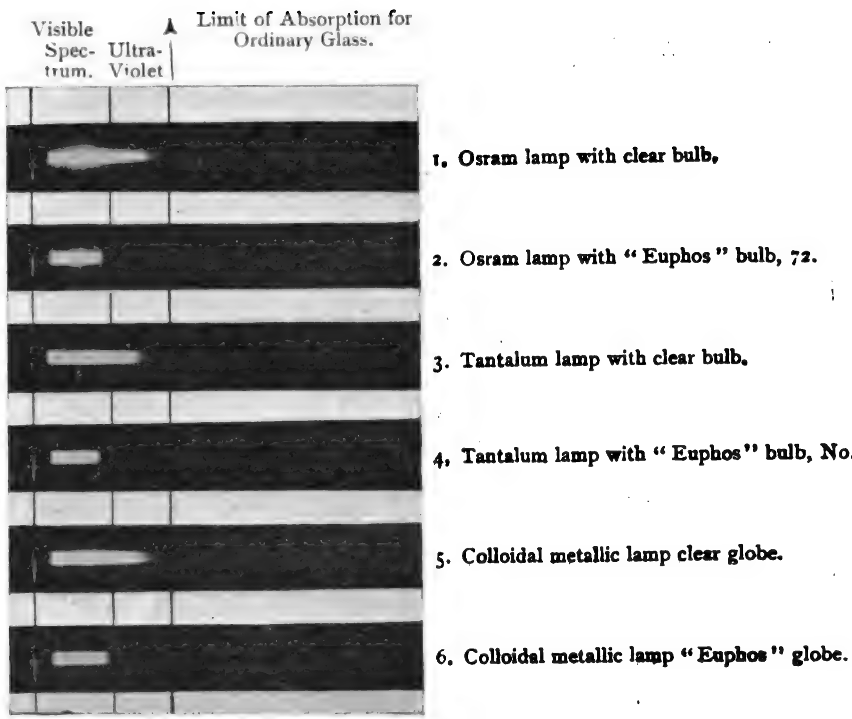
VISIBLE AND ULTRA-VIOLET SPECTRUM OF NERNST LAMP. (Exposure 20 min., showing effect of Euphos glass.)

used under ordinary practical conditions. It is for instance worth noting that according to medical authorities this ultra-violet constituent in sunlight is not without value on account of its supposed germicidal properties, and the free access of sunlight into interiors is regarded as one of the conditions which is most effective in counteracting the effect of any lurking tuberculosis bacilli.

applicable. In addition, such an expert must be a man of wide sympathies, not only willing and able to appreciate the economical and technical aspects of problems, but also in touch with the physiological and aesthetic aspects.

Such a man has yet to be evolved, and I have termed him "the expert illuminating engineer." I need not say that his development must be gradual, and his career for the present largely one of self-education.

FIG. 93.



VISIBLE AND ULTRA-VIOLET SPECTRUM OF METALLIC FILAMENT LAMP. (Time of Exposure 20 min., showing effect of Euphos glass.)

CONCLUSION.

I now come to a few final remarks before winding up this course. If I have done nothing else in these lectures, I hope to have succeeded in giving you an idea of the vastness of this subject, and of the many different points of view that have to be taken into account, and the contradictory data which require to be reconciled. What is needed is a man who shall be independent of any connection with any particular system of lighting, but who will take an impartial and unprejudiced view of them all, and therefore be capable of deciding to what case each particular illuminant is best

It may perhaps seem to some of you that in parts of these lectures I have dwelt in a somewhat pessimistic manner on the defects of modern conditions of lighting, and harped too insistently on the many directions in which there is admittedly room for improvement. It must not be imagined, however, that I do not recognise that there has been most encouraging progress in certain respects, and that modern methods of illumination are in many ways a great advance on those in existence a few years ago. One of the most satisfactory

indications of progress, perhaps, has been the steady growth of interest in matters of illuminating engineering; but what is now needed is to systematise and focus this interest to a greater extent, so that development may proceed on the proper lines. In dwelling on what remains to be done rather than on what has been done, therefore, I have been chiefly influenced by the desire to point out the necessity for such impartial and systematic effort, and the many fields in which substantial improvement might be made through the agency of an Illuminating Engineering Society and the illuminating expert engineer, whose development from existing professions such a society will, it is hoped, eventually bring about.

The urgent need at the present moment is for some method of bringing those interested in different aspects of illumination into one camp—a society which would enable them to appreciate each other's points of view, and would lead to mutual toleration and goodwill. In my paper read before the Society about three years ago, I referred to the need of the illuminating engineer, not dreaming at the time that the subject would have advanced so much as it has in this short period.

The time has now come for the formation of an Illuminating Engineering Society in this country. Many of you may know something of the immense progress and good work done by the society existing with this name in the United States. Since their start over three years ago, the number of members of this society has swelled from ninety-three to over 1,000.

At an informal dinner held on February 9th of this year it was decided to form a similar society in this country. Its object I have tried to explain to you, but I may repeat that all that is desired is a common impartial platform for the free discussion of these problems. Anyone interested in the subject is eligible as a member; at present, the membership will confer no professional status.

At a subsequent meeting on May 25th of this year, the draft-constitution of the society was formally adopted, and since that date the society has received influential support both in this country and on the Continent, from which I have just returned after hearing the views of the chief authorities on illumination, all of whom cordially approved our efforts. It is, I may mention, the intention to give the society as far as possible an international character, in order that concerted action may be taken in the future on matters of international importance.*

Before closing the lecture now, I feel that I ought to express my thanks and keen appreciation of the great kindness of the many who have assisted me, and to whose efforts any good results obtained are largely due.

I will, therefore, first of all, express my thanks to the very large number of manufacturers who have helped in exhibiting apparatus on such a generous scale.†

These lectures may serve as an object-lesson to those who have contended that it is impossible for one man to gain the sympathy of those interested in all the different methods of illumination. I think that you will admit that I have at least tried to preserve an impartial attitude in delivering these lectures.

And next I must express my great indebtedness to the Royal Society of Arts for granting me such exceptional facilities in order to make the exhibition of these systems of lighting possible. I have been allowed the privilege of introducing inflammable substances into this lecture theatre, to run piping, and to cause no little inconvenience by the constant stream of those engaged in the erection of the exhibits. This might be taken, however, as an indication that, with due precaution, all these systems can be regarded as safe methods of lighting and that there is room for the application of them all.

Thanks are due to Professor Stirling for the instructive series of slides and diagrams illustrating the construction of the eye, which he has kindly sent from Manchester University, and also to Professor J. T. Morris and Dr. C. V. Drysdale who have assisted in the same way. I should like in particular to express my appreciation of the services of my assistant, Mr. J. S. Dow, who has helped me throughout with the preparation of these lectures.

If I have inadvertently omitted to make due reference to some apparatus, or did not devote enough time to some points on which fuller discussion may have been desirable, I can only plead the exceptionally wide scope of the subject.

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* Anyone who would like to hear further particulars regarding this society is invited to apply to Mr. L. Gaster, Hon. Secretary, 32, Victoria-street, London, S.W.

† A list of the exhibits, and the manufacturers who kindly arranged them for these lectures, will be found on pages 291, 3.6, and 348 of the *Journal* for this year.

THE FUTURE WHEAT SUPPLY OF THE WORLD.*

Within a year of the last visit to the Dominion of the British Association the question was raised by the then President of that body at the Bristol meeting of 1898 whether the possible wheat-fields of the globe possessed a potential capacity of expansion sufficient to meet the hypothetical needs of the bread-eaters of even one generation ahead; whether, in fact, a dearth of wheat supply was not already within sight, and by 1931 would be upon us. The fixation of nitrogen, not as a dream but as a certainty, was claimed by Sir William Crookes as the condition on which the great Caucasian race was to avoid being squeezed out of existence by races to whom wheaten bread was not the "staff of life." Personally I confess I am not so pessimistic as to the surface still available for wheat-growing even without this aid. If we granted that the so-called contributory areas, at a date two or three years before the close of last century, were just what was then stated, that the bread-eating population of that date was rightly guessed at 516,500,000—a much more difficult certainty to reach in the manner adopted by the American statistician whose figures were adopted—and that both the growth of population and of "unit consumption" would proceed exactly in the ratio suggested, it might legitimately be asked, does it nevertheless follow that no such increment of area could be looked for as would satisfy the larger mass of consumers calculated as likely to be dependent upon wheat in 1911 or 1931 on the scale here laid down? We might admit that the course of the wheat acreage from 1870 to 1884 and thence onward to 1898 showed—first, a material advance outstripping that of population, then an admitted check with a subsequent advance, although one below that of the bread consumers of the world. Is not, however, a later view of the wheat area at the disposal of the world's consumers well qualified materially to diminish, if not to dissipate, the "cosmic scare" which was induced by the figures of 1898? If the growth of men outstripped the growth of wheat, as was the case between 1884 and 1897, the growth of wheat-fields has been well over the rate of population increase since that exceptional period, just as it was in the still earlier period between 1871 and 1884. Nor was the check to the rye acreage and its decline by four per cent., which seemed to have happened with the wheat check between 1884-1897, continuing; for that, in the aggregate, seems to have returned to, though it has not perhaps much exceeded, the older level. In the decade 1897-1907 the increase to be accounted for was 34,000,000 acres. The Russian quota formed more than a third of the whole. Now it was Russia that was in a very special degree the subject of unfavourable remark in the wheat problem controversy ten years ago. She was spoken of as having reduced her consumption of bread by 14 per cent., only by this means continuing her exports in defiance of her true needs, and contributing to the rest of the world, therefore, a merely provisional and precarious excess.

* Abstracted from the Presidential Address of Major P. G. Craigie, C.B., to the Agricultural Sub-Section of the British Association, Winnipeg, 1909.

Russia.

The exports of wheat from Russia, which we were warned would not continue, and which had doubtless been unusually large between 1893 and 1898, shrank for three years after that date as if they would realise the prophesy which would relegate Russia from the ranks of exporters to the task of feeding her own population. But that mysterious Empire had since then resumed her large supplies, and from 1902 to 1906 the exports ranged higher than before. Although forming only 24 per cent. of her estimated wheat crop, Russia's exports averaged 141,000,000 bushels over the first five years of this century, against 104,000,000 bushels over the whole preceding 15 years. Quite lately we seemed to see some restriction, but the history of the trade forbids a confident opinion that she has reached the end of her contributions to other lands. In the two decades stretching from 1887 to 1906, European Russia had added 1,000,000 acres of wheat per annum. This is not only a 70 per cent. advance in 20 years, but it is double the absolute area of 10,000,000 acres which the United States added in this interval. From such official estimates as were furnished, the total produce of the 50 Governments, where alone the figures were continuous, increased in a still higher ratio. The average production, which did not exceed 180,000,000 bushels in the five years before 1879, or 226,000,000 bushels in the quinquennium ending 1889, reached what appeared to have been a maximum in 1904, and was averaged at 415,000,000 bushels for the whole five years' period then ending. If the later years were again at a lower level, they represented very nearly double the produce before 1879. The yield per acre, which stood below eight bushels to the acre between 1883 and 1892, averaged nine bushels over the next ten years, and has been 10·9, 10·4, and 11·4 bushels respectively in the three seasons ending 1904. In the south-western region, where the yield was just over eleven bushels in the decade ending 1892, it seems to have averaged 15 in the ten years ending 1902, while over 18 and 19 bushels were reported in 1903-1904. These figures omit the Polish, Caucasian, and Asiatic districts, for which a much smaller retrospect is possible. The acreage in Poland is small — little over a million—and nearly constant in extent. But the wheat of Northern Caucasia, first accounted for in 1894, rose from 5,600,000 acres to 8,300,000 in 1906, and the Siberian totals, after increasing, apparently, but slightly, from 3,400,000 acres in 1895 to 4,800,000 acres at the close of the century, do not seem much to exceed 5,000,000 acres now. Inquiry shows that the wheat extension in Russia has been made possible by an actual addition to the arable land, and not by deduction from other crops.

Argentina and Australia.

In the forecasts offered ten years ago Argentina, as a wheat-grower, was given a dozen years from 1898 to reach a possible acreage of 12,000,000 acres. She reached that figure and passed it in less than a decade, and later official current estimates seem to concede to that region a close approximation to 15,000,000 acres to-day. As the actual pace here has bettered so considerably that prophesied, one might legitimately question the further limitations which allowed to Argentina no prospect of ever reaching a wheat area of 30,000,000 acres at any time. No one could note the strides which she has taken in rapidly augmenting her wheat areas and exports, and that concurrently with the commanding place she is assuming as a meat rearer and exporter to the older peoples of Europe, without some recognition that a great future is possible. Small, relatively to the great extent of surface included in the Commonwealth of Australia, is the proportion under wheat, but the Commonwealth is none the less, as a rule, an exporter. A little more than 30 years ago only about 1,400,000 acres were grown. This seems to have been a good deal more than doubled in the 5 years 1876-81, when a much smaller rate of increase followed for 15 years. After 1896 wheat-growing came again into favour, and the rapid spurt which followed brought the Commonwealth total to 5,700,000 acres as the century closed. Thereafter the rate of growth seemed checked anew, and after passing a maximum of just under 6,300,000 acres, it stands to-day under 6,000,000 acres. Twice during the last 20 years has Australia shown on balance a net importation of wheat, but from 1903 to 1907 the quantity exported has averaged 36,000,000 bushels. It is not without interest to observe that the Australian exports of the present century have not all been consumed in Britain; South Africa, the western coasts of South America, and even some parts of India have shared in the surplus product of the Antipodean Continent. The conditions and the future of the Australian wheat have been quite recently dealt with in an interesting paper read before the Colonial Section of the Royal Society of Arts, by Mr. A. E. Humphries, who pointed out that the soils on which it was grown were rich in assimilable nitrogen, requiring little manurial expenditure in that direction, but poor in their percentage of phosphoric acid, while the climatic conditions as regards moisture had proved remarkably difficult. Efforts have been made, and apparently, if recent experiences were confirmed, with success, to breed new varieties of the wheat plant adapted to the peculiar climatic conditions of Australia and likely to increase the low average yields hitherto obtained.

Canada.

The forecast of the Canadian future made in 1898 was surely unduly pessimistic. The opinion then quoted by Sir William Crookes as that of trustworthy authorities, assigned to the Dominion a bare total of 6,000,000 acres under wheat as all that could be expected to be reached within a dozen years. That period has not yet fully come, but by December 31, 1908, the official figure showed an acreage as reached within the decade which exceeded by 10 per cent. the maximum allotted to 1910. If the figure ascertained for the 1909 crop be added, a total of 7,750,000 acres is now reckoned upon, so that here again the forecast has been outstripped. The further proposal to estimate the maximum of the Canadian potential capacity for wheat production by 1923 at no more than 12,000,000 acres would therefore meet severe critics in Winnipeg to-day. It is a relief to turn from the perplexing variety of speculations as to the future to the relatively more solid ground afforded by the actual records of wheat extension. There are defects of continuous statistics showing from year to year the total acreage of the Dominion, although the recent good work of the Census and Statistics Office promises that this will henceforth be remedied. But outside of the three great wheat-growing sections—Ontario, Manitoba, and the North-West—the surface under this cereal is not material. The decline in Ontario, where, as in older settlements, wheat-growing shrank as more diversified forms of agriculture evolved, is much more than compensated for when the acreage of Manitoba, and in later years the rest of the North-West, is superadded, and the rapidity of the recent extension testifies to the energy in the task of bread-raising which this hopeful section of the British Empire displays. But it is clear that our statistical records require a further development and a much improved continuity, especially in the new regions of the wheat supply of the future. Nor can we dispense with the urgent lesson that science has much to teach us in making more use of the areas acknowledged to be under more or less rudimentary cultivation. If Sir William Crookes was right in adopting the American statistician's average of 12·7 bushels per acre as the mean of the recognisable wheat fields of the world, the prospect of the extra seven bushels he sought as immediately desirable would make us eager to learn the very latest triumphs of the laboratory in winning for the soil a freer measure of the nitrogen of the air. But hopefully as we may wait on the chemist's help, I, for my own part, incline still more confidently to the botanist. The producer of new and prolific and yet disease-resisting and frost-defying breeds of wheat plants is to-day more than ever encouraged by what has been done in many lands of late in this direction, to suit the crop to its environment. Nothing could be a greater boon to the wheat farmers, handicapped by a short and irregular supply of summer warmth, and the occasional but often untimely invasion of the frost fiend, than the production of varieties of wheat at once prolific and early ripening, and suited to the relatively scanty moisture of semi-arid regions. The farming of the future must ultimately be one of more careful tillage, of more scientific rotations, and of

consideration for the changes in the grouping of population, and in the world-wide conditions of man and his varying wants. What is going on all over the world has to be learned and studied, and wheat pioneers of the North-West must not forget the possibility of yet new competitors arising in the single task of wheat-growing, whether in the still developing sections of the Russian Empire and the still open levels of Argentina, the little known regions of Manchuria, the basin of the Tigris and Euphrates, the more completely irrigated plains of India, the table-lands of Central Africa, or perhaps under new conditions and a more developed control of the reserves of water supply, on the southern shores of the Mediterranean, or even in the long-tilled valley of the Nile.

THE TURKISH TOBACCO INDUSTRY.

Cigarette tobacco is one of the chief crops, and one of the most important exports, of Turkey. It enjoys a high reputation everywhere. In 1908 the United States alone purchased from Samsoun, in the district of Trebizond, £117,000 of cigarette tobacco. In that part of Turkey, tobacco is grown chiefly at Samsoun, Bafra, Trebizond, and Platana. Very large quantities of Trebizond tobacco are sold to Egypt, where this tobacco is used to brighten the tobacco obtained from other parts of Turkey. Trebizond tobacco is not strong, it has very little aroma, the leaves are large, very light coloured, and do not keep very well. Samsoun and Bafra tobaccos are stronger, have more aroma, do not sting the tongue, while the leaves are smaller and darker. According to the American Consul at Trebizond, the most aromatic kinds are what are called "marden" (mine) and "dere" (valley) varieties. These leaves are very small, strong, dark, and aromatic. The country where the best Turkish tobacco is grown in Trebizond is a low, mountainous region bordering the south shore of the Black Sea. It lies between the 40th and 41st degrees of North latitude. A chain of mountains, once densely wooded, but now quite bare, 2,000 to 8,000 feet high, runs along the coast at varying distances back from the sea, and seems to act as a curtain to hold the clouds and the moisture which rises from the sea. Most of the tobacco fields are on the slopes of the foothills and in the lower valleys, from half a mile to three miles from the shore. As a rule they are small, not exceeding from one to four acres. Snow is not abundant in this region, and there is little frost. It is considered desirable that the ground should freeze a little in the winter before it is cultivated. Rain is quite abundant until June, and the atmosphere is nearly always humid. In the Trebizond district a clear sky and a bright sun are extremely rare. The summer is hot. The tobacco fields are not irrigated. According to the general opinion, it is climate rather than soil that causes the difference in the various kinds of tobacco. The methods of tobacco culture are primitive, and much is left to chance and nature. No systematic rotation of crops is practised, no scientific fertilising, and little cultivating. Some fields are planted with tobacco year after year without any rest, while a few, the least desirable ones, are left fallow every three or four years. About the middle or end of March the seed, mixed with a little sand, is sown on a small bed of ground at one side of the field or in some garden. The starting bed is carefully dug and hoed and cleared from stones and weeds. When the plants are from four to six inches high they are transplanted in the field, and set out in rows about eight inches apart, and the plants placed about a foot apart in the rows. They are watered once or twice when first set out, and rarely after that. Little weeding or cultivating is done. No machines are used. At Trebizond, when the tobacco is from twelve to fifteen inches high, the tops are broken off and the shoots are pinched. A few stocks are left for seed. At Samsoun, little or no budding or pinching is done. There they try to get many small leaves, while at Trebizond they look for large leaves—quantity rather than quality. Harvesting begins in the latter part of June, and the pickings follow one another throughout the summer. At Trebizond there are three pickings:—(1) The lowest leaves and the poorest in quality; (2) medium leaves of medium quality; (3) the best quality, large leaves, strong and of darker colour. The seeds are gathered in September and no use is made of them except for planting. In Trebizond the average yield is about 800 pounds of tobacco per acre. In Samsoun it is about 750 pounds, and in Bafra it averages about 900 pounds per acre. In 1908 Trebizond, including Platana, produced about 60,000 hundredweight. The leaves, as gathered, are placed on strings, each quality by itself, and the strings are hung on horizontal poles. They are dried in the sun near a cabin so arranged that in case of rain the poles can easily be run into the cabin to protect the tobacco. After the leaves have been well dried they are put into a damp house or cellar where they remain until they become soft when they are made up into packets of six to ten leaves. Subsequently they are taken to the Tobacco Régie depots where they are sorted, manipulated, weighed, and sold either to the Régie or to the tobacco merchants.

TRADE IN SOUTHERN PERSIA.

Major Ducat, H.M.'s Consul at Kerman, has just sent home his report on the trade of his consular district for the year ended March last, and dwells at some length on the moot question of transport in Southern Persia, which has been the subject of frequent discussion and comment for a few years past. It may be remembered that in 1906 a Com-

mercial Mission to Southern Persia was organised by the Chambers of Commerce in Northern India, with the approval and assistance of the Government, and placed in charge of Mr. Gleadowe-Newcomen, who, on his return, drew up a most interesting report on the subject, a summary of which appeared in the *Journals* of March 29th, and April 5th and 12th, 1907. Since then the conclusion of the Anglo-Russian agreement has definitely placed Southern Persia in the sphere of Great Britain, and has drawn renewed attention to the necessity of doing all that is possible, in the interests of British trade, to open up the country and develop its means of transport. Towards the close of last year, a City company entered somewhat exhaustively into the subject, and was advised that the first great requirement was the construction of a good road from Bunder Abbas, *viâ* Regan and Bam, to Kerman. Estimates were duly obtained, but the revolutionary movements in the Shah's dominions and the disturbed condition of the country prevented the project from being carried out.

Major Ducat now enters fully into the same subject. He points out that the position of Kerman is one of exceptional importance. It occupies the summit of the great plateau of Persia at an altitude of some 6,000 feet, and between it and the other large towns on the plateau — Teheran, Ispahan, Shiraz, Yezd, and Kashan—there is no range of mountains or any obstacle to a road or railway. It is the only large town on the plateau which can be reached from the sea without any serious obstacle, or to which a road or railway would entail no heavy cost or engineering difficulty, and some day it will be the chief large inland town on the main southern route into Persia. Meantime, however, though the caravan route has no kotals (passes) to surmount, has good water all the way, and halting places with provisions at convenient intervals throughout, it is probably worse provided with transport than any known route in the world connecting a town of 60,000 inhabitants, with a busy seaport 350 miles away. There is no organised carriage service, and consignees are entirely at the mercy of a few ignorant and short-sighted camel drivers, who will flatly refuse to take an unusually shaped package at all, and even for merchandise, packed specially, will unblushingly make a written contract to deliver within 80 to 90 days at a rate of about £12 10s. a ton. During 2½ years' experience, Major Ducat says, the shortest time he has known a caravan to arrive in has been 35 days, and as even a camel covers 2½ miles an hour, this means an average day's march of four hours with five halts. The postal service, when it was in working order, took 20 to 30 days to deliver a weekly mail from Bunder Abbas, and now letters drop in at intervals of five and six weeks. Telegrams from Kerman to Bunder Abbas first go north to Teheran, then south to Bushire, from Bushire to the island of Herijam by cable, and thence from Herijam to Bunder Abbas by boat, when one happens to be available, and weather permits.

Meantime the roads have been impossible except for well-armed parties able to beat off attacks, the mails have practically ceased coming, and communications have been more and more restricted. As a matter of fact, transport has never been easy to obtain in the district, and, if the reported robberies are authentic, all the transport animals except camels are in or have passed through the hands of robbers. Among the imports figure piece goods, yarns, sugar, tea, matches, indigo, copper, candles, and coffee, while the well-known Kerman carpets are the principal exports, these varying in size from the small "pushti" (1 foot by 2 feet) to the large carpet for the hall and the "biggest in the world" hotels of New York. The total value of carpets exported was £90,000 in 1908-9, and is likely to increase so far as New York trade is concerned, though the trade to Constantinople, the only other mart, may fall off in proportion. The other exports are natural produce, such as gum, almonds, and pistachio nuts, or raw material like wool, cotton, and hides.

The description given by Major Ducat of the life and wants of the people, points to a very primitive state of society. From a trade point of view their education is practically untouched. Their wants are still almost confined to necessary food and scant clothing. Obtaining easily these simple wants, and having no knowledge of any others, or means of satisfying them if they have, they contentedly idle away nearly a quarter of the year. Though not a third of them really keep the fast, practically no work is done throughout the month of Ramazan. It is equally impossible to get anything done during the month of Maharram. From Naoroz till the thirteenth day after every man, woman, and child is holiday making, and every month of the Mahommedan calendar has one or more "eeds," or "katls," which are kept as holidays. In the winter if there is a heavy fall of snow, or a particularly cold snap, the bazaars close, and everyone sits indoors over a colossal brazier for a week if it lasts so long. Major Ducat says that to send him catalogues of motor launches, mining and boring machinery, steel structures for buildings, or inquiries for the addresses of shipbuilders and ship chandlers, denotes more ignorance of the geography and civilisation of the district than an intelligent effort to extend markets.

THE OUTLOOK FOR TIMBER SUPPLIES.*

Much attention has recently been given to this subject, and the general opinion is that prospects are not reassuring. Britain paid twenty-seven millions sterling for wood on the average of the five years 1904-8, as compared with eighteen millions in 1889-93, an increase of 50 per cent. Even Germany, with nearly twelve times the area of forest that we possess, pays annually some twelve millions sterling for im-

* Abstract of a paper read by Professor W. Somerville before the Agricultural Sub-Section of the British Association, Winnipeg, 1909.

ported timber. Although the U.S.A. exports wood and wood-products to the value of twenty millions sterling per annum, she has to pay as much for imports. In Europe, Sweden and Russia are the chief timber-exporting countries, and it seems unlikely that these countries can maintain supplies. Sweden, it is officially stated, is over-cutting her forests to the extent of more than 100 million cubic feet yearly, while Russia is already reducing her exports. In various official publications the Department of Agriculture of the United States has drawn attention to the prodigal method in which her forests are exploited, and has pointed out that in a few years she will not even have timber enough for her own supplies.

There are only two regions of the world that may contain sufficient areas of virgin coniferous forest appreciably to affect the situation. The one is Canada, which in the North-West, and also North and East of Lake Superior, contains large tracts of untouched forest. The growing stock of large stretches of country west of the Rocky Mountains is undoubtedly large, and is now having an appreciable effect on market supplies. The timber that may become available along the line of the new Grand Trunk Railway is more problematical. The area is vast, but the density of the stock is said to be poor, and the individual trees and rate of growth are small. The other region of the world that contains large stretches of virgin forest is Siberia. Although the density of Siberian forests cannot compare with well-stocked land in Europe or America, her areas are so vast that it cannot be doubted that this country possesses enormous stores of wood. But the difficulty in her case is to get them out. The navigation of the Arctic Ocean is too dangerous to be undertaken for timber cargoes at anything like present prices. Nor would it be profitable to move timber along the Trans-Siberian Railway. The only way to get part of Siberia's timber to market is to float or ship it down the rivers, such as the Amur, that debouch into the Pacific. This is already being done to some extent, and in time such supplies will go some way towards satisfying the demands of China, Japan, and Australia.

The growing scarcity of timber is clearly reflected in the supplies on the world's markets. Thus in Britain the largest class of timber has risen in value 28 per cent. in the last fifteen years. Concurrently with the rise in price there has been a marked falling off in quality, so that the real rise in price has been much more than the figures indicate. The United States Department of Agriculture recently issued a table, which showed the prices ruling for various classes of timber in various American markets during the past twenty-two years. Of thirty-two brands of timber, nine had risen over 100 per cent., and only two had risen less than 25 per cent. Effective relief through the agency of timber substitutes seems improbable. Concrete and iron are, of course, used to some extent in place of wood, and there is a talk of sugar-cane stalks becoming important in paper-making. But with it all, the demand for wood continues to grow, and although economic prophecies have often proved to be wrong, it seems impossible to escape the conclusion that the future of the world's timber supplies is distinctly disconcerting. It would therefore appear to be in the interests of every country to take energetic steps to prevent the wasteful destruction of timber by forest fires, to see that denuded areas are at once regenerated, and to undertake the planting of all land that can be better utilised under silviculture than through the agency of pastoral occupation.

HOME INDUSTRIES.

The Wheat Position.—The comparatively high prices of last year induced wheat growers to increase the area of cultivation, and the crops of wheat from this increased area are expected to yield at least an average production per acre. The Hungarian Minister of Agriculture, in his usual forecast of the world's crops, estimates the total yield of wheat this year at 432,087,000 quarters, as against 397,257,000 quarters last year, an increase of 32,830,000 quarters. *The Times* estimate is some 9,000,000 quarters less, at 423,000,000 quarters, and it puts the figures for last year at 393,000,000 quarters. Assuming these latter figures to be near the mark, the prospects this year are for a total yield of 3,000,000 quarters more than last year's production. It is estimated that countries not growing wheat enough for home consumption will need to import roughly 70,000,000 quarters, and to meet these requirements the exporting countries are estimated to have a surplus of fully 81,000,000 quarters, the United States coming first with 20,000,000 quarters, and Russia and Argentina next with 13,000,000 quarters. If these estimates are approximately correct, the world's crops may yield some 11,000,000 quarters above the world's requirements for the year ended August 31st, 1910. This would seem to mean a further reduction in prices, which have already fallen considerably as compared with the high-water mark of two months ago, English white wheat from 45s. 6d.-48s. to 39s.-42s., Australian from 47s. to 44s., La Plata from 46s. 6d.-47s. to 44s., and South Russian from 47s.-47s. 6d. to 39s. 6d.-42s. 6d. But it must be remembered that, owing to two years of short crops and high average prices, the supplies in sight are less than half the quantity in view two years ago, and the invisible supply has also been severely trenched upon. It is estimated that the wheat in sight at the beginning of September was some 7,000,000 quarters less than two years ago. The visible supply in the United States has fallen from 6,500,000 quarters two years ago, to 1,142,000 quarters in 1909; the stocks at United Kingdom ports have fallen in the same period from 2,405,000 quarters to 1,110,000 quarters; stocks on the Continent from 900,000 quarters to 600,000 quarters;

whilst the quantity afloat for the United Kingdom, and for orders, has shrunk from 2,160,000 quarters in 1907 to 2,065,000, and the total quantity afloat for the Continent has increased from 1,110,000 quarters to 1,265,000, the total visible supply in 1909 being 6,182,000 quarters as against 13,075,000 quarters in 1907. On the whole, it seems probable that there will be some further decline in prices.

The Trade Boards Bill.—As was anticipated, this Bill met with no difficulty in its passage through the House of Lords, and it is greatly to be hoped that it will fulfil, or partially fulfil, the expectations of its authors. But experience of the legislative attempts to ameliorate the condition of the residuum warrants a certain scepticism. Everyone sympathises with the object of the Act, the prevention of sweating; everyone hopes that it will get rid of the sweater, and that his disappearance will mean fair wages for the sempstress and her like. But will it get rid of the sweater? Sweating is now a punishable offence, but it is not all punishable offences that are punished. If the law ordered the sweater to pay fair wages, and compelled him to do so, his workpeople would benefit in the way in which it is assumed by many the Trade Boards Act will benefit them. But Parliament has passed no such enactment, and if it had it could not enforce it. What it has done is to order the sweater not to pay wages below a minimum. And this direction will force him to do one of two things. Either he will give up his business, or, by the collusion of his workpeople, he will evade the law. He is not at all likely to change the character or methods of his business, and it must be remembered that many, if not most, of his workpeople are unequal to the good work for which those who pay the minimum wage will stipulate. It is sweated work under conditions which destroy health, and make life not worth living, but they prefer, say, 5s. a week to nothing. At least a large percentage of them know that they will never get the higher wage the law says ought to be theirs, and they prefer the sweater's wage to none. If that be so employer and employed are likely to join in hoodwinking the law. There are many Acts in force for the better housing of the poor, but the good that was expected to result from them has not accrued in anything like full measure because landlord and tenant unite to evade the Acts. And so it may well be with the Trade Boards Act. The sempstress and others included in the Act will not, it is to be feared, be the allies of the Government in enforcing it because it will seem to them that "a half loaf is better than none," and they may not be persuaded that the Act will give them the whole loaf.

Machinery Cleaning.—According to the "Textile Recorder," a method is now being employed in the United States by which compressed air is used to blow the dust and fibrous accumulations off machinery, the air being conveyed thereto by means of a flexible tube with a metal nozzle. When humidifying installations are of the pressure type they may be used to supply the air for the cleaning tubes. The "Textile Recorder" instances the case of a spinning mill in which records have been kept for twelve months, the saving effected being approximately £9 per 1,000 spindles per annum. The vacuum cleaning method has also been attempted, but not very successfully. In England there is small heed to the waste of time caused by machinery cleaning. Usually the engine stands for a short time once or twice a week, say in all an hour. Taking the working hours per week at 55, this means a loss in output of about 2 per cent.

Nitrates from Air.—The British Consul-General at Berlin, reporting upon the manufacture in Germany of nitrates from air, says that the industry is still in the first stage of development. In full working order the principal German works at present engaged in the manufacture can produce about 21,500 tons of nitrate of lime per annum, a quantity which will be increased to about 41,500 tons when the plant now in course of construction is completed and in operation. Projects for a number of other works are under consideration, the most important being the erection of large nitrate of lime works in Bavaria. A factory has also been built in the Tyrol by a Westphalian company, which is capable of producing about 3,000 tons of nitric acid, and from this a corresponding quantity of nitrate of lime. It is estimated that about 1,300 tons of nitrate of lime were sold in Germany in January and February last. At this rate, the sales for the whole year will amount to over 7,500 tons, or about 1½ per cent. of the total quantity of natural saltpetre annually consumed in the country. As more works are completed, the manufacture of this artificial manure must increase, but probably a considerable time will elapse before it seriously affects the natural product.

Sunday Work at Sea.—In January last, the Board of Trade sent out a letter, addressed severally to the Chamber of Shipping of the United Kingdom, the Shipping Federation, and the Liverpool Steamship Owners' Association, dealing with the question of Sunday labour on board British ships when lying in port, whether at home or abroad. The Board, whilst recognising that the varying conditions under which British merchant ships carry on their business in different parts of the world, make it difficult, if not impracticable, to lay down hard and fast rules as to what work the crew may properly be required to perform on Sunday, are satisfied that they may rely upon the co-operation of shipowners in restricting such work within the narrowest possible limits. And the Board went on to suggest that any reasonable ground for dissatisfaction might to a large extent be removed if the officers and crew of a vessel received extra remuneration in cases where work on Sunday in port is found to be essential. The shipping bodies addressed were asked if they saw any objection to the insertion of a stipulation in the printed form of agreement providing that the officers and crew shall receive

extra pay at a stated rate per hour when called upon to perform work in port on Sunday. The shipowners have emphatically rejected this suggestion. They say that not only would any differentiation in the days of duty applicable to seamen cause friction and disorganisation of work on board ship, but it would still further handicap British shipowners in their struggle with foreign competitors whose working expenses are already so much less costly than in British vessels, but such a stipulation would defeat the object aimed at and increase rather than lessen Sunday labour. The Chamber of Shipping of the United Kingdom gave it as their opinion—an opinion endorsed by the other shipping authorities consulted—that officers and crews are, as a rule, so desirous of receiving extra pay that if such a hard-and-fast clause as that suggested were to be put into ships' articles the work of the ship would be planned by the officers so as to render it necessary that work should be performed on board ships in port on Sunday.

OBITUARY.

John Jones.—By the death of Mr. John Jones, which happened on the 6th instant, at his residence, Manor-house, Send Green, Surrey, in his 95th year, the Society loses its oldest member, since he joined it sixty-six years ago, in 1843. Up to 1907 he paid an annual subscription, and on his expressing a wish to retire, since at his great age he could no longer even read the *Journal*, the Council felt justified in electing to life membership one who had so long supported the Society. Until age made him retire from business, Mr. Jones took a very active interest in the work of the Society, frequently contributed to the discussions, and wrote letters to the *Journal*. He was a man of energetic character, and of an independent turn of mind, and never hesitated to give expression to his opinions. His first appearance in the *Journal* appears to have been in 1856, when he wrote protesting against certificated schoolmasters not being permitted to enter for the Society's examinations. His last appearance was in 1881, when he took part in the discussion on an interesting paper, by Mr. Berly, on "Pneumatic Clocks," then lately introduced into Paris. Mr. Jones was in business as a watchmaker, and seems to have been the first to introduce a moderate priced watch. "Jones's Workman's Watch" was well known for its low cost and good quality at a time when it was impossible to obtain a trustworthy timekeeper, except at a very considerable price.

He was perhaps the first to suggest the encouragement of technical education by the City Companies, when in 1854 he induced the Turners' Company, of which he was one time Master, to offer rewards for turnery. He was an active and respected member of the Common Council, where, as elsewhere, he had a habit of speaking his mind. He was also a member of the Metropolitan Board of Works at the time of its dissolution.

GENERAL NOTES.

The Illuminating Engineering Society.—This Society will enter upon its opening Session next November. Prof. Silvanus P. Thompson, D.Sc., F.R.S., has consented to be the first President, and influential support has been received from many distinguished authorities on matters of illumination in this country, on the Continent, and in America. Among those who have expressed their sympathy with the movement by becoming Vice-Presidents and Corresponding Members are:—Dr. Bell (Boston, U.S.A.), Dr. L. Bloch (Berlin), Prof. A. Blondel (Paris), Dr. E. Budde (Berlin), Prof. H. Bunte (Karlsruhe), Sir William Crookes (London), M. Sainte Claire Deville (Paris), Prof. H. Drehschmidt (Berlin), Mr. E. L. Elliott (New York), Dr. A. H. Elliott (New York), Prof. J. A. Fleming (London), Dr. E. P. Hyde (Ohio, U.S.A.), Dr. H. Krüss (Hamburg), Mr. V. R. Lansingh (New York), Prof. Vivian Lewes (London), Sir William Preece (London), Sir Boverton Redwood (London), Prof. S. Rumi (Genoa), Dr. E. Schilling (Munich), Prof. H. Strache (Vienna), Prof. K. Ulbricht (Dresden), Dr. W. Voege (Hamburg), Sir H. Trueman Wood (London), &c. Any one interested in the objects of the Society and desiring to become a member is invited to apply to Mr. L. Gaster, Hon. Secretary, 32, Victoria-street, London, S.W.

The Cost of Living in Bahia.—In his report on the trade of Bahia just issued (No. 4313, Annual Series), Mr. Consul O'Sullivan-Beare gives some striking figures to illustrate the high cost of living at Bahia consequent upon the heavy import duties plus local taxation. The Federal Government has imposed on Bahia, in addition to ordinary duties, a special tax of 2 per cent. gold upon all articles imported. The proceeds of the tax serve as a guarantee in connection with the scheme of projected harbour works at the port. To take some of the Consul's figures:—

	Cost. Reis.	Duties. Reis.	Percentage of duties. Reis.
Jams	16$000	34$000	212
Onions	220,000	1,356,000	616
Tinned vegetables ..	18,000	62,000	344
Wines	102,400	268,000	262
Brandies	13,000	40,000	310
Whiskies	15,000	33,000	220

Dried vegetables pay duties varying from 80 to 260 per cent.; cheese pays 131 per cent.; cocoa 161 per cent.; chocolate 221 per cent.; ham, 100 per cent., and so on.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

THE MAHRATTA PLOUGH.

By Sir George Birdwood.

In omni quidem parte culturæ, sed in hac quidem, [*i.e.*, arandi disciplina] maxime valeat oraculum illud: "Quid quæque regio patiatur."—C. Plinii, "Nat. Hist.," xviii. 18.

This defence of the Mahratta plough was originally written in reply to the sweeping attack on the vernacular implements and operations of Indian agriculture, made in a paper read on the 16th of July, 1888, before the East India Association, by the Pandit Srilal, a distinguished student of the Royal Agricultural College at Cirencester, and late Secretary to the Agricultural Society of Bijnaur, the northernmost District of the Rohilkand Division of the North-West Provinces. As it would not be possible within the space at my disposal to attempt a general rejoinder to the accomplished Pandit, I restrict myself, for the present, to the vindication of the indigenous plough, in regard to its perfect adaptation to the surrounding conditions of the land, and life, and labour; and in so doing I confine myself to that part of India known to me familiarly, in the strict etymological sense of the word, from my birth, and dear to me as my native country,* the "great" basaltic "kingdom" of Maha-rashtra.

* The name of my birth-place, Belgaum, is Canarese, its correct form being Vennu-grama [" Bamboo—my 'Tree of Life'—Town"], and it was included within the limits of the ancient Karnataka, or "Canara [literally "Black Soil"] Country." The Mahratta language is, however, spoken right up to Belgaum, and the Ghat-prabha [" Pass-leader"—my "River of Life"—] river rising by numerous affluents in the Sabyadri mountains [" Western Ghauts"] between the Hanuman and Ram *ghats* or "passes," and flowing past Belgaum and Gokak, westward to the Kistna, now bounds the extremest southern marches of "the Mahratta Country"; and, up to its junction with the Kistna, divides the basaltic formation of Maha-rashtra, from the granite plateau of Karnataka.

PART I

The Mahratta Country, or "Ager,—*aut rudis et immanis, aut silvosus, aut arvus,* [i.e., *aratus et consitus,*] *aut pascuus, aut florens.*"

Its Limits.

Hindu geographers divide the Dakhan, or India "south" of Hindustan [the alluvial plains of the Indus and Ganges] into six principal provinces—viz., (1) Guja-rashtra, north-west of the Narbada; (2) Gondwana [the Central Provinces], south-east of the Narbada; (3) Andra or Telingana [the Nizam's Dominions, *et cetera*], south of Gondwana, to the Coromandel Coast; (4) Dravida [Travancore, *et cetera*], in the south of the peninsula; (5) Karnataka [Mysore, *et cetera*], on the Malabar Coast, north of Dravida; and (6) Maha-rashtra, extending from the Ghat-prabha river—which separates Maha-rashtra from Karnataka,—nearly 500 miles north to the Satpura mountains the watershed between the Tapti and Narbada rivers; and from the Malabar Coast, 300 to 400 miles eastward to the borders of Telingana and Gondwana; the westward border of the latter province being defined by the Wardha river, a northern affluent of the Godavari.

These are the extreme ethnographical frontiers of the Mahratta Country; but its political limits have been enlarged by conquest even beyond them;—past the Wardha river, and past the old Bhonsla city of Nagpur, right up to the Wain-ganga, the eastward affluent of the Godavari; and again across the Narbada, where Mahratta dynasties have permanently established themselves at Baroda [Gaekwar] in Guzarat, and at Indor [Holkar], and Gwalior [Sindhia] in Central India. These subject Mahratta States are, however, excluded from the present survey; as are also the Khandesh District [Baglana], or basin of the Tapti, be-

tween the Satpura mountains and the Chandor hills; and the whole of the Nasik District; and all the six northern subdivisions of the Ahmadnagar District, forming with the Nasik District, between the Chandor and the Ahmadnagar hills, the fluviatile area, wherein are gathered, by its head stream and western affluents, the waters discharged by the pastoral Godavari, through Telingana, into the Bay of Bengal. The latter tracts are termed, indiscriminately, by the Mahrattas themselves, Vindhyari, that is, belonging to the Vindhya ["the Hunters'"] mountains, and are still in large proportion peopled by the Bhils* ["Bowmen"], and other aboriginal tribes, who, from the remotest prehistoric times have had their home in Gondwana, whereto Khandesh truly appertains, rather than to Maha-rashtra.

The boundaries of the true Mahratta Country, therefore, are:—on the West, the Arabian Sea from Goa to Bombay, 250 miles; on the North, the Kalyan river from Bombay to the Sahyadri mountains, at the Malsaj *ghat*, 70 miles as the crow flies, and thence, along the Ahmadnagar hills, so far as they extend due east, 100 miles more; on the East, the south-eastern prolongation of the Ahmadnagar hills to beyond the sacred Mahratta city of Tuljapur, and the fortress of Nuldrug, both in the Nizam's Dominions, 120 miles in all; and on the South, an irregular line from Nuldrug to Goa, crossing the Bhima, the great contributory to the Kistna from "the Northern Mahratta Country" [the Ahmadnagar, Poona, Satara, and Sholapur Districts], about 60 miles south-east from Pandharpur, the holiest of Mahratta towns, and the main stream of the Kistna itself, 30 miles south from the splendid ruins of the mediæval Moslem city of Bijapur, and just east of the influence of the Ghat-prabha, the south-most contributory to the Kistna from "the Southern Mahratta Country" [the Kolapur State, and Bijapur and Belgaum Districts], a distance, as the crow flies, of altogether 200 miles.

Within the area thus circumscribed, the most characteristic Mahratta territory is, according to Grant-Duff, the region of upland dales, about 50 miles in breadth, and 200 in length, extending across all the eastward spurs of the Sahyadri mountains ["Western Ghats"] from Junnar on the Bhima, southward through Poona, the capital of the old Mahratta Peshwas,* on the Muta Mula, an affluent of the Bhima, and through Satara, on the head stream of the Kistna, to Euru-Manjira, lower down the same river, a little east of Kolhapur. These mountain valleys, locally termed *mavals*; and the wide straths of the Bhima, and its affluents the Sina and Nira,—[the Bhima and Sina, rivers flowing side by side, between the Ahmadnagar and the Poona hills, and the Nira between the Poona and the Satara, or Mahadeo hills, and the open vale of the Kistna, where it opens out southward from Satara, and away east from Kolhapur, into Telingana, together with the precipitous, low lying, narrow maritime belt of the Konkans, to the west of the Syhadri mountains],—all this well wooded, and well watered, and well laboured, fertile, and inaccessible, and strongly defensible country, is "the very heart of heart" of the mighty basaltic tableland of Maha-rashtra: toward which the hearts of all its true sons, the hardy, brave, shrewd, hospitable, and intensely devout *mavalis*, the Scotch of India, are drawn, as with a fourfold cord, by its romantic and sublime picturesqueness, its bounteous fruitfulness, its profoundly emotional associations with the religious poetry of Tukaram [*circa* 1609 to 1649], and by the heroic history of Sivaji [1627 to 1680]: —Tukaram, who passionately extols the glory of Vithoba or Vithal, the popular incarnation of [Krishna]-Vishnu, and of Pandharpur, the seat of Vithoba's noblest shrine, and of the Bhima, the perennially flowing, broad-meadowed river of Panharpur;—and Sivaji, the typical and greatest leader of the historic Mahratta race, at once their Wallace and Bruce and Douglas, to whom they owe the imperishable and inspiriting memories of an independent national life centred for 108 years [1650 to 1818] at Poona; this city, on account of its commanding strategic position,

* The Mahrattas are mixed, but true Aryas, and represent the south-west extension, *en masse*, of the Aryan race in India. The Bhils are unmixed aborigines, or Vindhyan Dravidas, and are represented south of Khandesh by the Varalis [north of Bombay], Kathodis [north of Poona], Ramusis [north of Kolhapur], and other semi-savage tribes of "the Western Ghauts," who form the autochthonous substratum of the lower out-castes of the gallant Mahratta nation.

* The Pesh-wa [literally "Fore-man"], was the Prime Minister of the Mahratta kings; and the office becoming hereditary in the family of Balaji Rao, they gradually usurped the supreme authority, reigning in great power at Puna [Poona] between A.D. 1718 and 1818: leaving to the royal family of Sivaji only the petty principalities of Satara and Kolhapur. The word *pesh* in their title is Persian, and occurs also in Peshawar, "the *Frontier* station," in Peshin, "the *Front*-land," *i.e.*, "Sun-rise," or "Morning-land [Anatolia], as viewed from Persia; and in such words as *pesh-kash*, "what is *fore*-drawn, *i.e.*, "first-fruits, "taxes": *pesh-qi*, "money *advanced*"; *pesh-kabs*, "*fore*-grip," a dagger, the blade of which curves forwardly from the handle; *pesh-ani*, "the *fore*-head"; *pesh-ab*, "*fore*-water, *i.e.*, οὖρον, et cetera.

still maintaining its pre-eminence as the military capital of the Dakhan. It is the Kabul of Southern India; and as, according to the Eastern proverb:—"The Master of Kabul is the Master of Hindustan," so a ruler strongly seated in Poona, holds the entire Dakhan in his all confronting power.

I retain from childhood a lively recollection of the scenery and people of the whole of Maha-rashtra, between Belgaum and Indor, and Surat and Asirghar;* while with the Mahratta Country, as known to me in later years, and comprised within the administrative Districts of Poona, Ahmadnagar, Sholapur, Satara, Kolhapur [native State], Bijapur, and Belgaum, and, in the Southern Konkan, of Goa [Portuguese possession], Sawantwari [native State], Ratnagiri, and Kolaba, and, in the Northern Konkan, of Thana, I am more intimately acquainted than with any part of the United Kingdom, unless excepting the basaltic plains of the Forth and Clyde.

The Sahyadris.

The Sahyadris are the crest of the great wave of trap covering the whole of the western Dakhan from Belgaum to Indor, and from the Central Provinces to the Konkans, over which it hangs like a citadel of the Cyclops; attaining in the flat-topped mountain mass of Mahabal-eshwar, "the Great-strength-of God," its greatest height, 5,000 feet above the sea.

This aerial ramp lies almost at right angles to the direction of the South-West Monsoon, which beating on it through incalculable ages, has worn its sky line, where the trap rock is of harder basalt, into prolonged chains of bluff, flat-topped, terraced headlands; and, where of softer amygdaloid, into an occasional jagged peak; and at a lower height has moulded it, by the same process of secular denudation, into the confused maze of lateral spurs, between which the rain water of the Monsoon runs off in the head springs of the Kistna towards the east, and on the west in the numerous little rivers that plough their rapid way to the Arabian Sea through the Konkans. The black soil of the plains of the Dakhan has been chiefly formed from the Monsoon waste of the Sahyadris; and this soil, so well adapted to the cultivation of cotton, extends beyond the trappean tract of Western India, far into the south and east of peninsular India, where it gives its name both to Karnataka and the Kanaras.

The Konkans.

These mountains fall toward the west very abruptly, in terraced slopes, of alternate horizontal belts of evergreen woods and black bands of basalt, and sheer precipices, often of 2,000 feet deep, and rugged, irregular spurs, often reaching the sea in 20, or in some places 40 miles, and cutting up the Konkans into a succession of transverse ravines and gorges of incredible difficulty, and deep steaming valleys, covered with thick forests, mostly of bamboo and teak. On the flat top of an isolated hill of one of these spurs, stretched out between the Bor *ghat* and Bombay, Lord Elphinstone founded the sanatorium of Matha-ran ["The Top- of the wild"]. Rising abruptly, from almost the level of the sea, to a height of 2,500 feet, and standing like an advanced tower in front of the Sahyadris, it commands the most striking panoramic view of them, from the stupendous scarp of Harichandragar [Malsaj *ghat*] rising to an altitude of 4,000 feet, in the north, to the pinnacled precipice, called by the natives Nagphani, "The Cobra's Hood," and by Europeans, "The Duke's Nose," on the east, there marking the position of the Bor *ghat*, down to the levelled loom line of the mighty bluff of Mahabaleshwar in the extreme south.

The "Island of Bombay."

Matharan, and the twin flat-topped Prabal hill, and the remarkable, curiously serrated, saddle-back ridge of Bawa Malang, and the Panala Hill, surmounted by the basaltic column that gives it the name of Funnel

* Asirghar is one of the finest stations in India for the observation of sunrises and sunsets, and moonlight effects. In the clear sapphire of the earth's shadow we call the night the stars do not shimmer, but shine with the bright steady glow of distant orbs hanging at different altitudes in the illimitable heights of the heavens; and the face of the moon is seen in full relief, and to be not of silvern, but of a pearly radiance of the most exquisite nacre. The varying remoteness and magnitude of these worlds upon worlds define an interstellar perspective leading the eye in every direction, beyond "the Pillars of the Seven Planets," and beyond "the Towers of the Twelve Signs" of the Zodiac, on and on through endless vistas of glory into the very mystery of Infinity; and the mind, losing the sense of time, as measured by days and months and years, seems, by a transmutation overmastering all materiality and self-consciousness, to pass into the absolute, unconditioned, and perfect life and light of Eternity. These Vindhyan sunrises and sunsets also have their fulness of glory; and may be compared in their magnificence with those to be seen from Edinburgh Castle and Stirling Castle; but they have not the celestitude, and do not inspire the wonder, awe, and worship of the moonlit nights of Asirghar, ringing through all their sapphire depths with the angelic song of the *τρισάγιον*: "*Ἅγιος ὁ θεός, ἅγιος ἰσχυρός, ἅγιος ἀθάνατος.*"

Hill among Europeans, are the most conspicuous masses, crests, and peaks of the semicircular spur forming the southern watershed of the affluents, from the Malsaj *ghat*, the Tal *ghat*, and the Bor *ghat*, of the beautiful Ulhas or Kalyan [Callian] river, the principal river of the Northern Konkan; a corresponding semicircular spur is the southern watershed of the affluents, from the Bor *ghat* and the Sava *ghat*, of the Amba or Nagotna river, the most sylvan river of the Southern Konkan; and these two curved spurs, converging, from the north and south respectively, toward the west, before sinking out of sight, form the bright little archipelago of basalt islets, which, joined together by the clay deposits of the Kalyan and Nagotna rivers, and of the little Panvel and Patala-Ganga ["Infernal"—literally "Patent," *i.e.*, "Wide-mouthed"—"Ganges"] rivers, and by the shells and sand thrown up by the waves of the South-West Monsoon, constitute the compound island, lying like a natural breakwater in front of the common estuary of the four creeks of the Kolyan, Panvel, Patala-ganga and Nagotna rivers; and thus forming the magnificent harbour that has given its Portuguese name, and the commercial and naval control of the Indian Ocean, to the palatial city of Bombay;* rising from its bright green Esplanade, flush with the blue level of the Arabian Sea, like the apparition of another Venice, suffused with the richer golden light of the eternal sunshine of the East.

Beautiful indeed for situation is Bombay,—and for providential opportunity the joy and praise of all those whose business is in the salt deep! Among the palm groves, tufting the five basaltic monticules and mounds of the surrounding suburbs, sparkle the white walls of the houses of its opulent and luxurious merchant princes: this rare aggregation of natural and artificial features presenting a scene at once splendid, comfortable, and, in its encompassing alpine panorama, wonderful; and absolutely enchanting, when the blaze of day has set, and the silver moon hangs above all in the spacious silence of the clear midnight sky.

THE NORTHERN KONKAN.

There has always existed along the Ulhas, so far as it is navigable to sea-going craft, a great emporium of Oriental commerce, which, as this river became from age to age more and more silted up, gradually gravitated lower and lower down its course, from Kalyan, the Kalliana of the Greeks, in Buddhistic and later Brahmanical antiquity, to Thana, *i.e.*, Sthan, "the Settlement," in mediæval or Mahommedan times, and to the port of Bombay, its southern debouchure, in the modern, English period.

Bhiwindi, the Binda [*Benda*] of Ptolemy, five miles from the right bank of the Ulhas, opposite Kalyan, is thought to be an older Aryan mart than even the latter town, and was probably a primitive Vindhyan station; while the period of Portuguese supremacy in Western India is represented by Bassein, *i.e.*, Vassai, "the Settlement," at the extremity of the northern outlet of the Ulhas, which with its southern debouchure [and the sea], delimits a portion of the true mainland, the so-called "Island of Salsette," famous for its Buddhistic caves, dated between B.C. 100 and A.D. 50, at Kanheri. Chembur, two or three miles to the east of Mahim Causeway, joining Bombay to Salsette, and corresponding with the Portuguese town of Bandra west of Mahim, has been thought to be the Symulla [*Simulla*] of Ptolemy; but the latter is rather to be identified with Chaul, at the mouth of the Kundalika river in the Southern Konkan. Yet the white variety of the *pangri* (Erythrina indica] found by the ruined Hindu temple at this place,* and, in all the world, found only there, is to my mind a distinct relic of the ancient Buddhists, who, as their grove at Lanavla, beyond the Bor *ghat* shows, were enthusiastic aboriculturists. About ten miles north of Bassein is the common creek of the Tansa river, flowing from the Tal *ghat*, and of the sacred Vaitarna or Agashi river, the Goaris of Ptolemy, flowing from the Tal *ghat*, and the other *ghats* more to the north, which lead off, through their eastward gradients, the sources of the Godavari. About fifteen miles east from Bassein is the shallow and rapidly disappearing breakwater connecting the Ulhas or Kalyan river with the Vaitarna, and with them forming the spurious "Island of Sopara" or "Island of Agashi"; where yet stands the town of Sopara, the capital of the Konkans from B.C. 1500 to A.D. 1310. It is mentioned in the Mahabharata, under the name Shurparaka,

* The ultimate source of the name of Bombay is the temple of the tutelary island goddess Momba-Devi, "Our Lady of Bombay," an auspicious local form of the "Great Goddess" Devi, the consort of Siva.

* The discoverer of this tree was Mr. Bhasker, the *Karbhari* of the Victoria Gardens, Bombay, where I was careful to propagate innumerable cuttings from it, and to distribute them widely, even so far as Egypt.

and also in the Mahawanso of Ceylon, and is now justly held to be the Ophir of the Bible, spelt Sophir by Josephus, this form of the word still denoting India among the Copts of Egypt and Abyssinia. Without doubt it is the Soupara and Nousaripa of Ptolemy, placed by him between Nousaripa [Nosari], in the Baroda [Gaekwar] State and Symulla [Chaul] in the Southern Konkan. The well-known tope* here, was recently shown by Messrs. Mulock and Sinclair, of the Bombay Civil Service, to be a Buddhist relic mound, dating not later than A.D. 100, and one of the most interesting as yet excavated in India. The saintly associations of this tumulus probably account for the traditional sanctity of the "Island of Sopara" or "Agashi," not less than the origin of the Vaitarna in the same sacred summits of the Sahyadris with the deified "delimiting" [Tamil Goda], and "cattle-bearing" Godavari.

The Aryas must have been early attracted from Gujarat into the picturesque and gloriously umbrageous coast land of the Konkans; and it was by moving up the Konkan rivers, and scaling their innumerable *ghats*, excavated by the descending rivers, that they finally reached and civilised Maha-rashtra, rather than through the forbidding Vindhyan regions of Gondwana and Baglana. The Buddhistic remains at Kanheri and Sopara, and the imposing later Brahmanical sculptures on the little island of Elephanta, in Bombay Harbour, prove, by the great wealth lavished upon them, that all through antiquity, down to the rise of the Mahommedan power in Anterior Asia, the creeks and estuaries of the Konkans were everywhere the busy scenes of the immemorial trade carried on between the Persian Gulf, Red Sea, and Eastern Coast of Africa, and Western India. We witness it actually pictured for us on the contemporary wall paintings of the Buddhistic caves at Ajanta [B.C. 250—A.D. 250] at the extremity of the northern bifurcation, within the frontiers of the Nizam's Dominions, of the Chandor spur of the Sahyadris. The inland routes of this commerce from Kalyan over the Bor *ghat* into the valley of the Kistna; and from Sopara over the *ghat*, into the upper valley of the Godavari, and on to Plithana [Paithan, *Baithana* of Ptolemy] on the lower Godavari, and Tagara* [Daulatabad, the Hindu Deogiri], about 50 miles north of Plithana; where on the southern bifurcation of the Chandor hills, the sumptuous Buddhistic *viharas*,† and later Brahmanical pagodas ‡ at Ellura, as also the marvellous mural paintings at Ajanto, 50 miles north-east of Ellura, testify to the affluent resources of the ancient, pre-Mahommedan trade of Maha-rashtra at its eastern *termini*, as graphically as do Kanheri and Elephanta at its western starting-places in the Konkans. From Nasica [Nasik] a branch from this easterly trunk road turned more to the north, and crossing in succession the Chandor hills near Chandor, the Tapti river, the Sautpura mountains through the Sindhiva *ghat*, the Narbada river, and the Vindhya mountains over the Jam *ghat*, at last reached Ozene [Ujjain] and Sagida [the *Sagida* or *Sageda* of Ptolemy] in Malva. These ancient routes are to be traced not only where they begin and end, but throughout their course, by the remains of Buddhistic and later Brahmanical architecture, as at Karli in the Bor *ghat*, where there is the largest and best preserved rock-cut *chaitya*, or Buddhist memorial hall [church], hitherto discovered in India; and at Bhaja and Bedsa south of Karli; at Junnar north of Poona, and Nasik north of Junnar; and at Kolvi and Dumnar near Ujjain. And the great Buddhist topes at Bhilsa [Sanchi] and Bharhut, 125 and 325 miles, respectively, east of Ujjain, are also indications of the far extended prosperity of the ancient trade of Maha-rashtra, rather than of the separate commercial system of the alluvial valley of the Ganges, cut off as the latter is from the lofty plains of the Godavari and the Kistna by the

* This Anglo-Indian word has a double derivation, viz., from the Sanskrit *stupa*, "a tumulus," as here: and the Canarese *topu*, "a clump of trees," as here also; the tope at Sopara having been so called by both Europeans and natives, from the vegetation on it, chiefly *karanda* bushes [Carissa Carandas], long before it was recognised, and first by Mr. Mulock, as a Buddhist mound.

* Tagara has also been identified with Deogiri, at the mouth of the Deogiri river, in the Ratnagiri District of the Southern Konkan, and the natural seaport of the Kolhapur State; while Mr. T. F. Fleet, of the Bombay Civil Service, identifies Tagara with the town Kolhapur itself, one of his arguments being that the *tagara* [*Tabernæmontana coronaria*] grows freely in its neighbourhood. There is a town called Tegur, a few miles N.E. of Dharwar.

† *Vihara* is a Sanskrit word meaning a Buddhist convent, and is traced in the name of the Province of Behar, in the Lieutenant-Governorship of Bengal; of the village on the Island of Salsette, near the great reservoir of the Bombay Waterworks; and, according to Colonel Yule [*Hobson-Jobson*], of the city of Bokhara in Central Asia.

‡ The Anglo-Indian word "pagoda," has also, like "tope," a double derivation, viz., from the Sanskrit *dhatu-garbha* "relic receptacle" [literally "tooth-womb"], though the Cyngalese *dagaba*; and from the Portuguese *pagao*, "a pagan." In India, however, the word "pagoda" is always applied to the idol-temples of the Hindus, and the word "tope" to the relic-mound of the Buddhists. The "pagodas" of China and Burma are Buddhist temples built [nominally] in seven stories.

defiles of the Jumna; which from opposite Delhi to opposite Allahabad and Benares, form the northern escarpment of the triangular trappean and granitic table-land of peninsular India. The beds of the Son and Narbada, forming a continuous waterway, sloping in opposite directions, from Patna [Palimbothra, *i.e.*, Pataliputra] on the Ganges to Broach [Barygaza] at the mouth of the Narbada, seem to open out a thousand miles of direct inland communication, through the very heart of Gondwana, between Northern and Southern India; but so inaccessible are the Amarkantaka highlands, in which these rivers, and the Mahanadi, the river of Orissa, have their common source, and so precipitous is the channel of the Narbada, and so intricate that of the Son before it reaches the plain of the Ganges, that these rivers, so far from serving to overcome, rather aggravate the obstructions placed by the Vindhya and the Satpura mountains to free intercourse between Hindustan and the Dakhan.

The strange admixture of religious ideas and practices current among the Mahrattas is only to be satisfactorily explained by the enlarged commercial intercourse with Anterior Asia, and Egypt, and the West, enjoyed by Western India all through the great Buddhistic millennium from B.C. 500 to A.D. 500. That commerce made Buddhism in the East, as, through Buddhism, it made Christianity in the West; while in Maha-rashtra, to the deeply-rooted and strongly infectious animism of the Vindhyan aborigines, and the Vedic polytheism of the Aryan settlers, it added the elements of Chaldæan sabaism, Egyptian asceticism, Roman stoicism, and some of the distinctive principles of that general humanitarianism of the period which at last found its highest expression in Christianity. Even Bible names are surmised to have been deified among the Mahrattas, who near Pandharpur worship an image called Bawa-Adam, and in the Berars another known as Jabral-Abral [? the Angel Gabriel]. I am satisfied that the glory of the legendary Hindu rajah Vikramaditya [of Ujjain] of this period, is in part the reflected glory of Augustus Cæsar; and that "the Nine Gems" of Vikramadityas Court are none other than Virgil, Horace, Ovid, and rest of the Augustan poets.

It was, in all probability, in the course of this secular trade between the East and West, and long before it became so intimate as it did between the dates of Alexander the Great and Justinian I., that the characteristic Mahratta drill ploughs, the *moghar* and *pabhar* were introduced into Western India direct from Chaldæa.

The Southern Konkan.

Janjira, at the mouth of the romantic Rajpuri creek, below Chaul, in the Southern Konkan, is supposed to be the Sigerus of the Greeks and Romans, and Mhasla, at the head of the creek, the Mousopalle of Ptolemy. Below Jinjira are Bankot, at the mouth of the Savitri river, flowing from Mahabaleshwar, and Dabhol, at the mouth of the Vashishti, both places of some trade in the Mahommedan or mediæval period; Ratnagiri, at the mouth of the Bhatya; Deogiri or Devgad, absurdly identified by some with the ancient Tagara; Malvan, at the mouth of the Kalavli, where the trappean formation is last seen in the Konkan; and Vengurla, where the gneissic series of Southern India first makes itself prominent on the Malabar Coast. None of these exiguous ports ever accommodated anything more than a precarious local trade, and being thus inaccessible to the international trade of antiquity, the narrow alpine strip of the Konkans between Chaul and Goa was never fully brought under its denationalising influences, and remained all through the thousand years of the predominance of Buddhism in Hindustan,—and in the Dakkan so far south as the left bank of the lower Kistna,—a safe refuge for the families of the conservative Aryan priesthood now known as the Konkanast Brahmans. The Brahmans of the Ganges valley affect to despise them, and in their disdainful and despiteful ignorance apply literally to them the traditional cognomen they bear of *Chitpavan*, *i.e.*, "a corpse saved from the funeral pyre," a figurative epithet probably condensing in a word the long history of their almost miraculous survival from the fire of Buddhistic persecution. But whatever may be the interpretation of the local legend of their origin, they are a well-grown, handsome race of men, with fair complexions, light gray eyes, and strikingly intellectual faces, and obviously of far purer Aryan blood than any other Hindu people east of the Gandak and Son, or south of the Kistna: and above all else, they present, in their manly and joyous national temperament, a complete moral antithesis to the witty and plaintive Bengalee Babus, a radically Turanian race. Such being their inherent aristocratic characteristics, it is not surprising that, on the collapse of Buddhism, and during the decline of the Mahommedan

power in India, emerging from their secure retreat in the Southern Konkan, they gradually, as of natural right, gathered into their masterful hands the whole administrative, political and social, control of the Mahratta nationality, and, from the Peshwar downwards, became the first and foremost personages throughout the Dakhan. Their mental superiority is shown by the manner in which their historic family names crowd the honours-lists of the Bombay University.

The *Chit-pavan* women are of the most refined type of feminine loveliness; and in the sweetness, grace, and dignity of their high-bred beauty, at once modern in its delicacy, and antique in its fearless freedom, they might well be taken for the Greek originals of the Tanagra "figurines," awaked to a later life among the tropical gardens and orchards and cocoanut groves of the Southern Konkan. One never wearies of watching them, as they are to be seen in the dewy morning in their gardens, perambulating, in archaic worship, the altar of Holy Basil [*tulsi*, Oocymum sanctum] placed before every Hindu house; or of an afternoon as they pass, in fetching water, to and from the near riverside, or the lotus-laden tank of the village temple, all in their flowing robes of cotton, of unbleached white, or dyed a single colour, pink, scarlet, black, green, or primrose yellow, presenting as they move, in the deepening shadows of the trees, along the red laterite roads, fitfully illumined from across the blue sea by the sidelong glances from the declining sun, the richest chromatic effects, in all the bright glamour of a glowing Turner or a Claude. And the outward and visible charms of these fair *Chit-pavnis* faithfully mirror the innate virtues of their pure and gentle natures; for they are perfect daughters, and perfect wives, and perfect mothers, after the severely disciplined, self-sacrificing, Hindu ideal, the ideal also of Solomon and Sophocles, and of St. Paul and St. Augustine, remaining modestly at home, as the proper sphere of their duties, unknown beyond their families, and seeking in the happiness of their children their greatest pleasure, and in the reverence of their husbands the amaranthine* crown of a true woman's glory in the highest.

THE KONKAN-GHAT-MATHA.

The ascent from the Konkans to the summits of the Sahyadris, or *Konkan-ghat-matha** ("Konkan-pass-top"), is very rapid. The old military road up the Bor *ghat* rises six hundred feet in a mile; and the Tal *ghat* is as steep. In order, therefore, to carry the railway from Bombay to Nagpur and Benares over the Tal *ghat*, and to Madras over the Bor *ghat*, the engineers had to take advantage, at the farthest possible distance from these passes, of the shoulders projecting from the main axis of the Sahyadris towards the Island of Bombay. In this way, along the Tal *ghat* incline, half the ascent is almost unconsciously overcome, and the final lift on to the plateau of the Dakhan is made, with comparative ease. The Bor *ghat* railway incline is almost fifteen miles in length, and its average gradient is one foot in forty-eight; the work consisting of a series of Cyclopean cuttings, tunnels, embankments, and viaducts, carried through and over some of the finest scenery in the world. Thus, starting at a wide distance from the military road, the railway line runs straight up until it joins the former at the old Toll House on the west side of a gorge, surmounted on its opposite or eastern side by the perpendicular precipice of "The Duke's Nose;" and from this point, where a Reversing Station stands, 1,548 feet above the sea, it doubles back, with the military road, to the village of Khandala, 1,786 feet above the sea, and continues its course past the ancient Buddhistic grove at Lanavla, 2,030 feet above the sea, and thence, down gradually descending gradients, on to Poona and Sholopur, and to Bellary and Madras.

The slope of the trappean formation of Maha-rashtra is very gradual from the Sahyadris towards the Coromandel coast, and these mountains, therefore, present on their eastern side very long spurs, sinking slowly into the general level of the Dakhan; but in starting from the same culminating headlands of the axial range, the eastward spurs, so far correspond symmetrically with those on the west. Thus, about sixty miles south from the Chandor, or Ajanta and Ellura, hills, the Ahmaduagar hills start from the mountainous mass of Harichandragar, rising 3,894 feet above the sea, and having a fort with walls 18 miles in circumference on its summit. Thence they run in a ridge on to Brahmanvara, where they are 2,866 feet in height, and then expand into a terraced tableland, twenty-four miles long,

* All-a-down the delectable Malabar Coast the women wear the flowers of the Globe Amaranth (*Gomphrena globosa*), cultivated in every garden, in their hair. Compare 1 Peter v. 4; and 1 Cor. ix. 25.

* Often spoken of simply as *Bala-ghat*, "the country Above-the-passes." *Desh*, literally "country," is the general plain beyond the *mavals*.

wenty broad, and from 2,474 to 2,133 feet high, at Ahmadnagar; whence they are continued southward, until they disappear in the neighbourhood of Sholapur and Nuldrug. A short secondary spur, jutting out from them close to their connection with Harichandragar, ends, west of Junnar, in the rugged rock of Shivnar, rising 1,000 feet above the surrounding plain; and the fort at its top was the birthplace of Sivaji. The famous temple of Bhimashankar, on the crest of the Sahyadris, 3,000 feet above the sea, midway between Harichandragar and Khandala, marks the sacred source of the Bhima, which, with its northern affluents, drains all the rich, fertile dale between the Chandor and the Poona hills.

Sivaji's Strongholds.*

The Poona hills originate in the territory [*jaghir*] of the Pant Sacheo of Bor, in a maze of spurs, merging in the course of ten or twelve miles in the spur that stretches south of Poona, separating the strath of the northern affluents of the Bhima from the dale of the Nira, the main affluent of the Bhima from the south. Close to the Sahyadris stands out boldly, to the height of 4,605 feet, the hill fort of Torna [cf. *tortus*, and torque, torch, torture, tart, &c.], so called from the contorted, or twisted, pinnacle of basalt, that marks its position from afar. It was here that Sivaji hoarded the booty gathered in his earliest forages. Immediately south of it is the hill, 3,392 feet high, that Sivaji, on finding Torna insufficiently secure against a surprise, fortified, and re-named "Raj-gar, "The Citadel of the Kingdom." About twelve miles west of Torna and Raj-gar is the hill fort originally called Kondhana, but re-named by Sivaji after he had captured it, Sinhgar, "The Lion's Den." Rising from 4,162 to 4,322 feet above the sea, and 2,300 feet above the plains below, it commands toward the north the whole vale of the Muta Mula, from the rich, evergreen forests [chiefly of Memecylon edule, and Carissa Carandas] about Khandala, to the open arable country, wherethrough, on the extreme east, the Muta Mula reaches the Bhima. In the middle ground, under the dominating hill temple of the "Great Goddess" Devi, in her name of Parvati, "The Mountaineer," the red-tiled roofs, and gaily painted house walls of Poona stretch hither and thither amid the deep verdure and towering foliage of the *agar* [cf. "ager"], or broad tract of enclosed orchards and gardens, and groves, and avenues of richly grown forest trees [*nimb*, Azadirachta indica, *pipal*, Ficus religiosa, and *bur*, Ficus indica] within which the fairest city of the Dakhan, the Damascus of India, lies far and wide embosomed. From the south, Sinhgar looks down upon the narrow, lovely valley of the Nira; but it is best seen from Sivaji's proud hill fort of Purandhar, 7 miles south-west of Sinhgar, standing 4,472 feet above the sea, and 2,566 feet above the plains of Poona, with the sparkling Nira flowing past its base, almost due south-eastward, for 70 miles, to the Bhima. On the right bank of the sunny Nira stands the sacred town of Jejuri, famous for its majestically-situated fane of Khandoba or Khanderao, a national incarnation of Siva, in the figure of an armed horseman, and, next to Vithoba or Vithal, the most popular object of worship throughout Maha-rashtra. Attached to his temple is a large establishment of dancing girls [*deva-dasi*, ἱεροδούλαι, ἑταίραι] Not far from the temple, and close to Nira bridge, is the village of Valhe, the reputed birthplace of Valmiki,* the legendary author of the divine *Ramayna*. In this valley also is Hol, the native village of the first Holkar. About 11 miles below the confluence of the Nira with the Bhima is the handsome city of Pandharpur, esteemed so holy, owing to the presence of the great temple of Vithoba, the national incarnation of [Krishna-] Vishnu, that the rich land immediately round it is restricted to the cultivation of the sacred *tulsi* plant, Ocymum sanctum, famed throughout India for its refreshing and sanative fragrance. It was the custom of all the principal members of the Mahratta Confederacy, the Peshwar, the Sindhia, and the Holkar, to keep up a house in this town; and here it was that the Gaekwar's ambassador, Gangadhar Shastri, was foully murdered in 1815, at the instigation of the degraded Baji Rao Peshwar, by the hired assassins of Trimbakji Danglia.†

* For a complete list of Sivaji's 145 fortresses, of which 89 still remain in the possession of the Mahratta Princes, see "Sivaji's Swarajya," a paper read before the Bombay Branch Royal Asiatic Society, 17th December, 1903, by P. V. Mawjee. J.P.

* See *The Triumph of Valmiki*, translated from the Bengali of H. P. Shastri, M.A., by R. B. Sen, B L., Chittagong College, 1909.

† Together with the names of the Hindu gods, and such titular names as the Peshwar, the Holkar, the Sindhia, the names of Gangadhar Shastri, and Trimbakji Danglia, were the most familiarly impressed on me from my earliest infancy in India, 1832-9; and Trimbakji Danglia's, with the vividness of that of a popular hero still actually alive; as for generations after their deaths the names of Robin Hood and Rob

About 60 miles due east from the junction of Nira with the Bhima, is the third sacred city of the Mahrattas proper, Tuljapur, an open town in the Nizam's dominions, containing numerous temples dedicated to Bhairava, a lower national incarnation of Siva than Khanderao or Kandoba. To the south and west of Purandhar the horizon is closed in by the Mahadeo or Satara hills and the Sahadri mountains, and beyond and above the latter, 44 miles due west of Purandhar, rises out of the Konkan, 2,851 feet above the sea, the hill fort formerly called Rai-ri, in Sanskrit Raygiri, "the Royal Hill," but named by Sivaji Raygar, "the Royal Fort." It is the strongest of his forts, "the Gibraltar of the East," where Sivaji held his coronation, in 1674, and died in 1680.

The Grave of Sivaji.

The scandent Bougainvilleia spectabilis irradiates with the exotic splendour of its loose waving tresses of majenta - coloured bloom the stately marble cenotaph of Akbar at Sikandra near Agra, a befitting emblem of the magnificence of the alien rule of the Mo(n)gols in India. As aptly, and yet more remarkably, because quite fortuitously, the grave of Sivaji, on the top of Ray-gar, is now to be traced only by the patch of one of the commonest wild flowers of Maha-rashtra growing over it, the Commelina communis, its exquisite bright blue petals reflecting back year after year the azure of the skies above, as if in sign of the great national leader's eternal peace with heaven.

"Poor Nellie's" Grave.

Another notable grave on these mountain tops is that of the botanist, John Graham, who died in 1839 at Khandala, and was buried there behind the Travellers' Bungalow, at the extremity of the grassy platform, thickly studded with the pretty white-flowered terrestrial orchid, Habenaria platifolia, overlooking the Khandala ravine; the spot being indicated by a short obelisk. South-west of the village of Khandala, beyond the barracks, in the old military cemetery on the slope of "Carnac Point," close under the "Duke's Nose," there stood 33 years [now 53] ago, out of the thick sward of the dark blue and white magpie-flowered Exacum bicolor, a headstone labelled simply "Poor Nellie," marking the grave of some English soldier's young wife, and hallowing all the hills around by the associations of its tender and heroic pathos.*

Mahabaleshwar.

The Satara hills project 100 miles eastward from Mahabalshwar, and from this main spur send off, toward the south-east, three subsidiary spurs, each about 50 miles long; the first,—running at a distance of from 5 to 10 miles from the Sahyadris,—separating the long, narrow dale of the Koyna, the west-most affluent of the Kistna, from the broad vale of the head stream of the Kistna, and of the Yerla, the largest of the direct eastern feeders of the Kistna within the Satara district; the second separating this vale from the valley of the Man or Man-ganga, a tributary of the Bhima; and the third separating the Man valley from the wide strath of the Bhima, which river receives the Man about 50 miles below the influence of the Nira, and after receiving the Sina from the east, about 25 miles south of the influence of the Man, itself becomes confluent, 100 miles farther south, with the main, eastward-flowing stream of the Kistna.

The head stream of the Kistna, with the Koyna, and the Yenna, a small tributary of the Kistna, all have their head springs in Mahabaleshwar, as also have the westward flowing streams ot the Savitri and Gayatri; and these five rivers, with the sacred Ganges, feigned by the Brahmans to derive a source, every fifth year, from Mahabaleshwar, are known to the hill-men of the locality as "The Six Sisters."

The Brahmans in charge of the temple of Krishnabai, "the Lady Krishna," at the head of the "Kistna Ravine," show you five rills of water running through five holes in the west wall of the temple, into a small tank, held of the highest sanctity, from which their collected waters flow through a carved stone cow into a second tank of lesser sanctity, and thence tumble down the steep side of the ravine into the Kistna; and they tell you that these five rills are the secret fountains of the rivers

Roy lived on in the memories of Englishmen and Scots. Bishop Heber's lines on his romantic escape out of our hands from the fort at Thana, in "the Island of Salsette," are well known :—

"Behind the bush the foemen hide,
The horse beneath the tree:
Where shall I find a knight will ride
The jungle paths with me?

"There are five and fifty couriers there
And four and fifty men;
When the fifty fifth shall mount his steed
The Dakhan lives again."

* I deeply regret that on inquiring after it, on reading the announcement of the publication, by the author of "My Trivial Life," of the novel entitled "Poor Nellie," I found that this touching tombstone has now [1888] disappeared.

Kistna, Koyna, Yenna, Gayatri, and Savitri; and as every drop of rain that falls on Mahabaleshwar, and every square foot of its oozy sward, may be said to be the common source of all the rivers flowing from it, the pious fantasy of these Brahmans is not to be lightly gainsaid. But in profane fact, even the Kistna itself rises a mile or two to the left of the temple among the runnels, formed by the superfluous drainage from the hill, below Arthur's Seat [Malet Point], the northmost point of Mahabaleshwar, and the water-parting between the Kistna and the Savitri, or river of Bankot. A south-westerly projection from Arthur's Seat, called Elphinstone Point, forms the water-parting between the Savitri and the Koyna, the latter winding past Lodwick Point, and Bombay Point, and Babbington Point, all on the west side of the Mahabaleshwar plateau, before continuing its south-easterly course inland, toward the Kistna. Babbington Point looks right down the long, green fairy-like dale of the Koyna, dotted throughout its length, along the course of its perennial river, with groves of tall trees, mango [Mangifera indica], jack [Artocarpus integrifolia], and *jambul* [Sizygium Jambolanum], and, towards the open plain of the Dakhan, *babul* [Acacia arabica], all indicating the sites of the hamlets and little villages, nestled within them, of the patient and skilful Mahratta cultivators, who have everywhere in these retired valleys carried the tillage of the *mavals* to the highest perfection.

From the temple of "The Lady Krishna," or from Kate's Point, three miles to the right, the valley of the Kistna opens out to the right, past Wai, and Satara, and Kurar, a gradually widening view of the plain of the Dakhan and its far-extended and ampler agriculture. But as both the summits and the escarpments of the hills on either side, as seen end on, present an unbroken outline, the prospect lacks variety; and only the vast magnitude of its scale, particularly in the immediate foreground, lends a sublime sternness to its severe monotony. Yet, visited in the still moonlight, and looked at from the Krishnabai temple, down on the sacred town of Wai, with its clusters of superbly sculptured shrines, as one yields sympathetically to the associations of the locality, the scene is one that makes an indelible impression on the memory.

From Arthur's Seat north-westward, across the dense forest that shelters the sources of the Kistna, extends the main axis of the Sahyadris; their blackened, trackless gorges, and bluffs of stratified basalt, stratum upon stratum, high uplifted to the zenith, and gigantic stacks of serried peaks, presenting, as thus viewed fore-shortened, a boundless prospect of the wildest desolation.

Lodwick Point is a narrow wall of basalt, not more than from 6 to 12 feet broad towards its extremity, running out 10,000 feet into the west, and there dropping down suddenly 2,500 feet into the valley of the Koyna below. The drop is so perpendicular that a runaway horse I once saw leap at full gallop from the Point fell dead at its base without striking against any salient ledge or angle in the fall. Projecting out into the sky, almost like a bowsprit from a ship, it commands a lofty perspective of the Konkans, in front of the main axis of the Sahyadris; but the predominant feature in the landscape here is the point itself, rearing its colossal wall, like a horse's neck thrown up inquiringly, above the deep, beautifully-wooded ravines of the Koyna on either side of it.

Bombay Point is so called from its having been there that the plateau of Mahabaleshwar was first reached by the old road from Bombay up the "Rotunda Ghaut."* It is a large space cleared out of a wood of noble evergreen trees, and fenced in, above the Rotunda Pass, by a low parapet, overgrown with Clematis wightiana [*murvail*], Hoya viridiflora [*hirandori*], the sweet-scented, white-flowered Jasminum latifolium [*kusur*], Embelia Basaal [*ambut*], and other luxuriant creepers and scandent shrubs. The view from it is the most extensive and varied and the most interesting on the hill; and hence this green, cool, and fragrant spot has become the general resort, of an afternoon, toward sundown, of the English families residing during the "hot season" at Mahabaleshwar. It is evergreen-wooded to its base, in the sweet valley of the Koyna, west of which the rugged, craggy spurs of the Sahyadris, stretching across the Konkans, present an infinite diversity of picturesque contours, spur beyond spur, without end, toward the north and south, and only bounded on the west by the glittering horizon of the Arabian Sea. It is said that sometimes a glimpse may be obtained beyond the long sylvan valley of the Nagotna river of Bombay, 100 miles distant; while southward the coast can be followed to Ratnagiri.

In the middle ground the low saddle-backed

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* That is, *Rortundi-ghat*, "the Roaring [or Crying] Pass," so called from the difficulty of its ascent; and the groans of the palanquin-bearers who carry you up it.

ridge, dipping down from Elphinstone Point, and forming the western enclosure of the Koyna valley at its head, suddenly ascends, before dipping down again to the Par* *ghat*, in Sivaji's massive flat-topped hill fort of Pratabgar. Only four miles distant, and rising by steep grassy slopes to an altitude of 3,543 feet above the Arabian Sea, distinctly visible on the left, it stands out boldly against the blue sky, directly in front of Bombay Point, and in strong contrast, when, after mid-day, its whole eastward side is in shade, with the bright, shining heights of the Konkans beyond. As the rays of the afternoon sun begin gradually to strike more and more horizontally through the heated, rarified mists drawn up by it during the forenoon, the natural complexion of this majestic scene undergoes a series of atmospheric transfigurations of indescribable splendour. At first the hills and dales of the Konkans seem to be suddenly transmuted into into silver, shining, as with its own light, in dazzling brightness along the ridges of the hills, but with a softer lustre in the dales, where their ethereal illumination is subdued by the lengthening shadows thrown by the sinking sun. Again, in the twinkling of an eye, all is changed to radiant gold, clear as topaz on the hill-tops, with the sea on the left ruled in long levelled lines of chrysolite; and when the day closes upon the eastern hemisphere, the rapidly falling mists pass from a glowing purple to dense indigo, and the cleared sky at last reflects back from the darkened landscape the deep transparent sapphire colour that is the proper tincture of an Indian night.

Mahratta Patriotism.

Before natural scenery of such spiritual expression and significance men have ever recognised that this outspread green earth, with the revolving circle of the sun and moon and stars above, is but the marvellous contexture of the veil dividing the world we see from the unseen, inscrutable life beyond: and inhabiting a country at once of great grandeur and loveliness, and of the strongest individuality of natural features and phenomena, the Hindus in general, and particularly the Mahrattas, have marked every hill and dale and river, and almost every "kenspeckle" tree and stone throughout India, by a shrine, altar, towering temple, or lone uncouth image, in acknowledgment of the felt presidence of the one polyonymous God of universal human worship; who is everywhere identified by some dramatic name, accurately descriptive of the most characteristic local manifestation of His might, majesty, and all pervading presence. Barren, scorched plains, and pestilential marsh-lands, and blackened, lightning-riven mountains are identified with Siva in some one of his higher or lower incarnations; and fertile tracts, and pleasurable prospects with Vishnu or Krishna; or with Siva's consort, "the Great Goddess," Devi, in her more auspicious aspects, such as Parvati, "the Mountaineer," Gauri, "the Yellow-haired," "Uma," "the Wanton," and "Jagan-mata," "the World Mother." Again, the money-making classes have for their tutelary divinities Vishnu, and his consort, the fair Laksmi, also called Loka-mata, "the World Mother;" while the ruling classes, whose duty it is to be "untender-hearted" [ἀμείλιχον ἦτορ ἔχων] worship Siva, and his consort Devi as Bhavani [Ἀθηνᾶ Πολιάς]. The armed horseman, Khanderao, is the historical Mahratta manifestation of the Godhead. The higher class of agriculturists are the devotees of Krishna and his loose lady-loves; while the favourite divinity of the lower class of agriculturists all through Maha-rashtra, and of all men in their less serious moods, is the playful monkey-god Hanuman, *i.e.*, "Long-jaw" or "the Prognathous One."

Thus throughout the length and breadth of the Konkans and the *mavals*, as surveyed from Bombay Point, from every height and depth there goes up the joyous salutation:

> "Thou art, O God, the Life and Light
> Of all this wondrous World we see!"

In everything the Mahratta finds God; the stones discourse of Him, the running brooks are His life-giving word,* every tree is a tongue in His praise, and every flower an Alleluia! This is the simple explanation of the intensity, the downright fanaticism, of the patriotism of the Mahrattas. Maha-rashta is not merely their mother country, but also their heavenly inheritance; while the presence of the Mahommedans, as religious persecutors, was regarded, not merely as a foreign intrusion, about which of itself they would have been very

* That is, "the Village," *par* or *para* being the Mahratti for "village" or "hamlet," but meaning literally "altar;" that is, the altar thrown up about the *pipal* [Ficus religiosa] or *bur*, or "banyan tree" [F. indica], round which every village or hamlet in India is built, and the village assemblies are held. *Par-ganah*, a revenue circle of many villages, is literally "the collection ["gang" of, Gana-pati, "Lord of Hosts"] of altars."

* A saying attributed to Mahomet.

indifferent, but as an absolute profanation and sacrilege, to be expiated at any cost.

Of all Europeans, the Scots are probably the most fervent in their patriotism; but Scotland after all is no more than their native country,—since the Reformation robbed them of their tutelary saints. It is not their Holy Land, where God has walked with man, which for them, as for all Protestant Christians, is far away in Jewry. To judge therefore of the Mahratta feeling for home and country, we have to conceive what perfervid Scotch patriotism would be, were Kishon a Scottish brook like Bannockburn; and evergreen Carmel, and Mount Gilboa, and Tabor and Hermon, spurs of the Cheviots, or the Lammermuir Hills; and the fragrant valley of Sharon, and the plain of Jezreel, "the seed plot of God," tracts of Tweeddale or Clydesdale; or were Flodden Field also the fateful field of Megiddon, as in sense it was, or,

"—— stately Edinborough, throned on craggs"

one with Jerusalem "the Golden."

"Thy terrettes and thy pinacles
With carbuncles doe shine.
Thy verie streetes are pauved with gold
Surpassinge cleare and fine.

Those statelie buildings manifold
In squares and streetes doe rise,
With gardens deckt, and lofty fanes
Eenclosed Castle-wise.

Quyt through the streetes with siluer sound
The Flood of Life doth flowe,
Upon whose bankes on everie syde
The Wood of Life doth growe.

There Magdalene hath left her mone
And cheerfullie doth singe
With blessed Saintes whose harmonie
In everie streete doth ringe."

THE APOTHEOSIS OF SIVAJI.

And it is in this conception of the Mahratta character that the foul and treacherous murder of Azful Khan by Sivaji at Pratabgar, must be estimated. From Bombay Point you can distinctly see the temple of Bhavani, in which Sivaji, Siva's son, solemnly dedicated himself to the terrible act, and the gateway in the circumvallation of the frowning fortress through which he walked down to meet the chivalrous, unsuspecting Bijapur general at the fatal trysting-place, to which the latter, with only a single attendant, walked up from the Koyna valley; and the very spot where he was so vilely assassinated, and where his body lies buried, is conspicuously indicated by an evergreen shrub [*apta*, Bauhinia racemosa], standing solitary on the hillside. The deed was damnable; but Sivaji, in all truth and sincerity, deemed it high and worthy, and the last sacrifice of his devout patriotism to the welfare of his sacro-sanct country; and it will be a bad sign for the Mahratta people if they ever come to think less of Sivaji for it. The Bijapur army lay between him and the independence of his country, and the only way in his power for destroying it was by the destruction of its commander, and hardening his heart to the necessity, he enticed his noble victim into an ambush, and in a paroxysm of sacramental ecstasy determinately slew him.

THE BOTANICAL WONDERS OF THE SAHYADRIS.

The Kolhapur hills start from the hill fort of Vishalgar,* 3,350 feet high, whence Sivaji made his incredible night raid on Mulhol, on the Ghat-prabha, 150 miles distant; and from Vishalgar they extend for about 45 miles eastward, being crowned near their extremity by the hill fort of Panhala, the last of the seven greater strongholds of Sivaji in the Mahratta country, where a dozen others of lesser note might be named. These hills are the waterparting between the Varna—forming, from its source up to its confluence with the Kistna at Miraj, the frontier between the District of Satara and the Kolhapur State,—and the Panch-ganga or Kolhapur river; and they are the only range of the confused mass of hills covering the Kolhapur district that runs out over the plateau of the Dakhan at right angles to the Syhadris. All the shorter spurs to the south of it run at a more or less acute angle toward the north, carrying northward the three terrestrial tributaries of the Panch-ganga,† which reaches the Kistna half-way between Miraj and Erur-Manjira; the point where the Kistna is joined from the south by the united streams of the Dudh-ganga, Ved-ganga, and Hiranya-keshi. Beyond Mudhol the Kistna is swollen by the Ghat-prabha, flowing almost due west from the Ram *ghat*, almost coincidently with the line of division between the trappean and the granitic Dakhan, and forming the natural boundary between Maha-rashtra and Karnataka.

The highest pleasures afforded by the scenery of the Sahyadris are for the botanist, and the flora of these mountains shows in its fullest glory in the Kolapur region between Vishalgar and the Ram *ghat*, the great pass.

* There is another Vishalgar fortress in the Thana District and a Vishalgar pass, or *ghat*, in the Ratnagiri district.

† The fifth tributary, constituting it "the Five-Ganges," is the celestial Sarasvati.

just beyond the Kolhapur frontier, between the shores of the Arabian Sea at Vengurla and Goa and the plateau of the Dakhan. I shall never forget my first vision of the Bombax Malabaricum, or "Red Silk Cotton Tree," in the Ram *ghat*.

I had left the plain below about 2 a.m., in medical charge of a party of about 250 European troops, and after a slow ascent of some hours, suddenly, at a turn of the road, just at sunrise, came out upon a glassy glade, overhanging the profound forest depths below, and there, at its farther edge, stood a colossal specimen of this tree, quite fifty feet high, the trunk straight as "the mast of some great ammiral," deeply buttressed at its base, and sending out horizontal branches, like the yard-arms of a ship, in whorls of five and seven, gradually tapering to the top, and at this season, the month of March, leafless, but covered on every branch, in place of green leaves, with huge crimson* flowers, each from seven to five inches in diameter, and forming in the mass a vast dome-like, symmetrical, head, that, with the beams of the rising sun striking through it, shone in its splendour of celestial, rosy red like a mountain of rubies. I fairly shrieked with delight at the sight of it, and galloped off at once toward it, followed in a rush by the whole column of men, who were mostly recruits, fresh from England like myself, and at last, by the young officer in command, who, on taking in the whole situation, a most picturesque one—the red coats swarming over the green grass up to the resplendent tree—from where he had stood in momentary astonishment at so unexpected a breach of discipline, after administering a kindly rebuke to myself, left us to sit on for awhile, worshipping in its ruby tinted light, before continuing our march to the top of the *ghat*. Again, when I first saw the Hoya vividiflora, "all a growing, all a blowing," in its natural state, on the lower slopes of Prabhul, opposite Matheran, before I knew what I was doing, I was off my pony, turning "cart wheels" round and round this mystically green-flowered scandent shrub. I could particularize many individual specimens of different gorgeously flowered species of forest trees, such as the golden yellow flowered Cassia Fistula [*bava*], the purple flowered Lagestrœmia reginæ [*taman*], the vermilion and chrome yellow flowered Butea frondosa [*pulas*], and the scarlet Erythrina indica [*pangri*], that, on account of their stately development, and the striking situations occupied by them at Matharan, Khandala, Mahabaleshwar, and the Ram *ghat*, are each one of them worthy, during the months of their glory, of a visit from England. For the present I may do no more than note, as an indirect proof of the great botanical charm of the whole region of the *Konkan-ghatmahta*, and the *mavals*, and of its recognition by the Mahrattas, that the Kolhapur State still bears its ancient name of Karavira [*Sirkar Karvir* in the vernacular], "the Oleander [-land]"; and that the white-flowered, fragrant dog-bane, Tabernæmontana coronaria, which, with the Nerium odorum, is found throughout the upper valleys of the affluents of the Kistna, probably gave its native name, as suggested by Mr. Fleet, to Tagara, whether we identify that ancient Indian city with Daulatabad in the Nizam's Dominions, or with the city of Kolhapur, "the Lotus-city," itself. At every turn in the *mavals*, the wayfarer comes on the bed of some mountain stream, tufted all along its banks, and all over the little green eyots amidst its waste of pebbles, with mixed sweet scented oleander and tamarisk, carrying the beholder back at once to the Ilissus, and the slopes of Mount Hymettus. The lovely blushing oleanders are always found to shade some pure, clear pool left by the river from its summer flood, at which the gentle maidens, and comely matrons, from the near village are filling their water-jars,—

> "a group that's quite antique
> Draped lightly, loving, natural, and Greek,"

as in the painting of the Rogers' vase of the women of Athens filling their pitchers at the fair flowing fountains of Callirrhoe.

The Plain of the Dakhan.

The central plateau of the Dakhan, or *desh* [*i.e.*, "[plain]- country"], as it is called by the natives, [in contradistinction to the *bala-ghat* or *ghat-matha*] eastward of the *mavals*, from Mudhol and Kaladghi on the Ghatprabha, northward past Bijapur, and past Sholapur along the Sena, to Ahmadnagar, and north-westward past Pandharpur and Indapur on the Bhima, and on toward Poona and Junnar, is an open plain, rising and falling in prolonged tame lines, the ground swell, as it were, of the boundless ocean of trap flowing over it. Solitary *turwur* [Cassia auriculata]

* By reflected light deep crimson; by transmitted, the radiant red of a ruby.

and *babul** [Acacia arabica] trees, and rare clumps of date palms, diversify it, and multitudes of mud-walled villages, the positions of which are shown in the landscape by lofty "topes" rising amid black ploughed fields, and breadths of corn and pulse and other crops, waving dark green over the wide arable expanse, save where interveined with the vivid verdure of the rice fields following the courses of the river beds. Some of these trap waves are mere mounds of trap rock, covered with a rusty-looking rubble called *mohrum*, its first debris. Others of greater amplitude are covered with black or brown soils, patched here and there with deep violet or jasper red, all more or less advanced stages in the decomposition of the same trappean debris. Earths similarly diversified fill up the intermediate troughs in the undulating champaign. The hard surface of the exposed trap is scarred with innumerable runnels, winding in and out among the clefts of the rock, while through the less resistant soil accumulated in the hollows, the gathered torrents have ploughed deep and straight channels for themselves. The black soil is the *regur* or "cotton soil" *par excellence* of India, already referred to as the inexhaustible priceless treasure of the agriculturists of the Dakhan. It covers all the most level portions of the *desh*, and is merely the ultimate stage of the brown earth derived by direct disintegration from the ferruginous rock on which it rests. Mixed with decomposed vegetation, and in conditions favourable to the solution of the alkalis combined with silica in its felsspar, it forms a rich, light, and pulverulent staple, equal in fertility and ease of cultivation to the finely lixiviated alluvium of the Nile, and the *looes* or celebrated fluviatile loam of the Rhine-lands, and *tschernozieme* or wheat soil of Southern Russia; all these natural soils, like the *regur* of the Dakhan, being derived ultimately from crystalline rocks.

Such is the unvaried aspect of the Dakhan beyond the limits of the eastern spurs of the Sahydris; and the way in which the landscape becomes broken up as these spurs are gradually approached, is well exemplified by following the Poona hills backward from Sholapur to Khandala. Advancing westward from the former station, along the old military road, we meet, at Bhigvan, a flat, terraced, and symmetrical hill, protruding abruptly from the plain, the advanced link of a chain, looming like a coast line along the right horizon. It is the lowest step, the outmost ripple of the Sahyadris. At Patus the ramifications of their spurs become more lofty and complicated, closing in on the road, which, always rising and falling, is yet a steady, although still more easy ascent. At Arangaon, the fourth halt from Sholapur, a jasper-red wackè, is met with it, capped by a decomposing ferruginous trap. At the line of contact with the trap the wackè is hard and lateritious, but lower it becomes more and more earthy. Wherever the trappean rocks exist in the Dakhan we are sure to find this laterite near; it generally caps the *ghats*; and, according to Dr. H. J. Carter, the distinguished geologist of Western India, it is essentially "formed of red iron clay, the iron of which, by means of segregation, has formed itself into cells and irregular tubes, chiefly at the expense of the clay contained in their interior." It would appear to be derived from basalt, first disintegrating into a wackè, and then, by a sort of reaction, becoming laterite. It is soft when fresh dug, but dries into a hard stone on exposure, and is thus admirably adapted for building. Great masses of this strange rock occur in the Nizam's Dominions, eastward of Sholapur. Its special feature at Arangaon is its association with a powdery calcareous deposit, usually found elsewhere in nodules, called by the natives *kankar*, occurring irregularly throughout it in immense heaps. Thus a nullah or watercourse, to the west of the town, passes for some distance through nothing but *kankar*, and then through *kankar* and wackè, mixed promiscuously together. The *kankar* from being more concrete than the wackè generally stands out beyond it. Both are indifferently overlaid by a secondary effusion of trap, that appears, where touching it, to have crystallised the *kankar* into radiated zeolites. In a field from which the secondary trap had been denuded, the mounds of *kankar* amongst the wackè are indicated by smooth, white, irregular patches, many yards in diameter, scattered over the red ground. At Bhigvan, the puce and lavender trap rock [amygdaloid], which is friable at Sholapur, is hard, and used as a building stone. At Mulud, a section of the river bank, at a spot near the camping ground, presents at its base a brown trap, veined with zigzag bands of

* I believe that this local name for the Arabian Acacia is an indication of its having been introduced into Western India from Babylonia. In Hindustani *babuli* means "Babylonian"; *babil-khana*, "a brothel," literally, "Babylonian house"; *babiliyth*, "enchantment," and "wine," and also "poison"—with a poetical signification. It has ever been but a step:—"From mystic Ind to fleshly Babylon."

kankar, and above this a solidified stratum of *kankar*, crammed with worn blocks of various traps. It has resisted the action of the river so much better than the trap below that it projects for some distance in a ledge beyond the latter. It is covered by a deep deposit of black soil. In many parts of the river bed the trap is so completely decomposed that, although looking quite hard, it can be dug out with the hands to obtain water, or to form extemporary bathing-troughs; yet every crystal in the rock remains *in situ*. Below the pebbly bed of the Bhima at this place layers of soft, plastic *kankar* were being dug into, when I was there 30 [now 53] years ago, by the railway engineers. Patus is situated in a *regur* plain of immense extent, studded by several low, tabular hills, covered with huge black blocks of basalt, and contrasting strangely with the shoreless green ocean of *jawari* [Sorghum vulgare] fields from which they rise. Some of the blocks are boulders, others, from their quadrangular form, and the accurate way in which they are piled on each other, evidently remain in the situations wherein they were upheaved, and have been simply unmasked by weathering. The distant horizon is bounded by lofty mountains, mostly tabular, rising step on step, like an amphitheatre; a solitary group on the west is peaked; while between their rolling spurs, projecting like promontories into the plain, stretch broad reaches of luxuriant fields for miles, like inlets of the sea. From Yevut, until amidst the basaltic ramparts that on all sides dominate Poona, the scene is open to the right; while on the left the road lies along the base of an unbroken range of flat, stratified heights, on the most prominent of which stands a Hindu temple. Onwards, and always upwards, to Khandala, the formation attains its grandest developments, rising to the immeasurable, flat-topped mountain masses of alternate green forest bands and black basalt cliffs, and the fantastic peaks and pinnacles, already described; and exhibiting after the outburst of the rains in June the added feature of the gigantic, although transient, waterfalls, that from every declivity and precipice, and through every winding gorge, pour down from June to September the flood waters of the ubiquitous affluents of the Kistna.

And from these altitudes, so attractive in their serene silence from October to May, and so awe-compelling in the appalling atmospheric passion and uproar of "the South-West Monsoon" [Hindu *mausam*, Arabic *mausim*, "season"], we again look down, [now north, now south of Bombay harbour], upon the low-lying Konkans,—their densely wooded hills and dales, their palmy plains, their shore belt of grey salt marshes, or vivid green rice fields, fringed westwardly with dark green mangroves,—and beyond all the pale-green waters of the Erythrean Sea; the whole paradisiacal scene shining in the setting sun with the transcendent resplendence of various verds and shimmering gold.

(To be continued and completed in Part II.—THE PLOUGH.*)*

ELECTRIC TURRET CLOCKS—NEW "WAITING-TRAIN" TYPE.

By ALFRED E. BALL.

Several different systems of electrically-driven clocks have been designed and are in use in which the hands are sheltered from the wind; but it appears that no electrical system for driving the exposed hands of large turret clocks exists which is capable of dealing with all atmospheric conditions.

It must be understood that turret clocks with exposed hands are compelled to work under conditions unfavourable to good time-keeping. At times, during a gale of wind, for instance, or a snowstorm, the hands (and consequently the clock) are helped forward, and at other times they are retarded, so much so that time-keeping is interfered with, and in fact public clocks are often found to be stopped after a storm.

Horologists have for many years past applied themselves to the problem of separating, if possible, the time-keeping function of the clock from the hand-driving mechanism in order that ever varying pressure of the wind on the exposed hands may not affect the time-keeping of the clock. To this end, various *remontoir* trains have been invented and a number of gravity escapements. The best-known type of the latter is probably that of the late Lord Grimthorpe, which is largely and in fact almost exclusively used in this country.

An arrangement which was probably first adopted in England and is now favoured for large clocks in America, is to provide a light, finely-made time-train and impose on it time-keeping duties only, while a heavy powerful train is provided for driving the hands, the progress of the latter being controlled entirely by the former. Such an arrangement is certainly a step in the right direction. A mechanical connection, however, has to be maintained between the two trains of wheels, and consequently the two functions cannot be entirely dissociated.

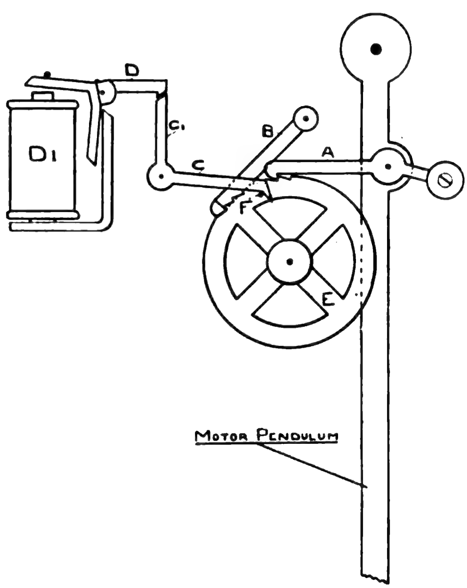
With an electrical turret system, however, which has been invented by the firm of Gent and Co., Ltd., whose factory is at Leicester, an entire dis-

sociation ot the time-keeping and hand-driving functions is obtained.

The electric hand-driving train, instead of being driven by a force of fixed value (such as a weight), as in a mechanical turret clock, which has to serve both when the load is heavy and light, is constructed so that its power becomes automatically adjusted to suit the load, the load in fact determining the power to be developed. The only connection between the hand-driving function and the time-keeping function in this new arrangement is the simple electric connecting wire, which obviously cannot transmit any mechanical resistance that may be applied to the hands.

This "waiting-train" movement consists essentially of a vibrating motor pendulum, and a half-minute time control. The vibrating motor pendulum, when working, becomes re-energised as often as the amplitude of its vibrations fall below a given value. In vibrating, the motor pendulum by means of a hook-shaped pawl, A (shown in the accompanying diagram No. 1), pulls around the 'scape wheel E, and the wheel-train gear, tooth by tooth.

FIG. 1.

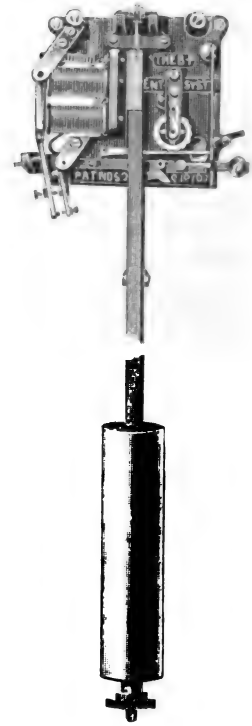


Normally the re-energisation of this motor pendulum takes place about once per minute. It is obvious, however, that if resistance is applied to the hands, such as is produced by wind pressure, storm, snow, &c., these re-energisations would take place more often, in fact, even as often as at each vibration, if necessary.

Working under these conditions, the motor-pendulum is found, as would be expected, to develop considerable power, even from 40 to 50 times that which is normally required. As all clocks with exposed hands have to deal with a varying load, the conditions of driving are completely met by the "waiting-train" movement.

The half-minute control operates as follows:— The simple train is so designed that the motor-pendulum in vibrating advances the hands half-a-minute in approximately 27 seconds. A pin, F, in the escape-wheel, E, then lifts the control-lever, C, and disconnects the pawl, A, of the motor-pendulum from the train of wheels by lifting it out of the wheel, E, and allowing the motor-pendulum to oscillate idly. It is here that the control from the entirely dissociated time-keeping mechanism comes into operation. This time-keeping mechanism (which is described

FIG. 2.



below) is known as the B.P. Patent Time Transmitter, and its duty is to send out electrical impulses precisely at each half-minute.

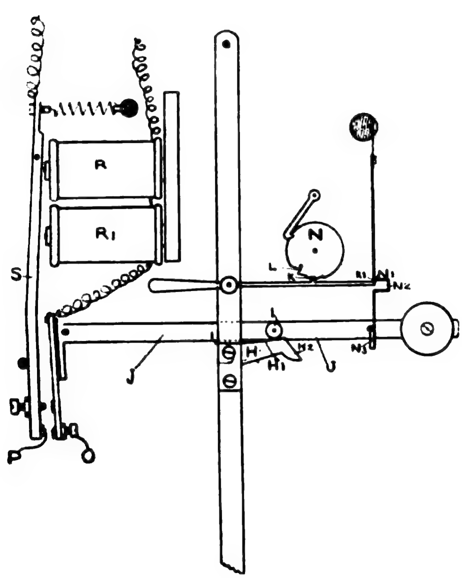
On the periodical half-minute impulse of the time-transmitter occurring, the control magnet, D1, becomes energised, the control lever, C, is released, and the motor-pendulum again drives forward the hands as before, the control being repeated at each and every half-minute, and in this manner the heavy exposed hands are propelled with practically a continuous motion. It is obvious that, no matter how exposed the turret clock driven by this system may be, its accuracy becomes equal to the accurate time transmitter controlling it.

The time transmitter mechanism effecting the half-minute control, and shown in illustration No. 2, is driven on a gravity principle which establishes

a new type of escapement or rather propellment, differing widely from gravity escapements hitherto employed. In the older types of gravity escapements, the pendulum is obliged to lift its own driving force at each swing in order to unlock the escapement. It has in fact to perform a recoil action. This work also is imposed on the pendulum at a time when it should be left severely alone, that is to say, at the end of each swing when its kinetic energy is at its lowest ebb, and when the pendulum is in a condition in which it would easily be influenced by varying friction while doing such work.

With the B.P. gravity principle the pendulum is entirely free at the end of each swing, and the work of unlocking the gravity lever and also the application of the impulse takes place when the kinetic energy

FIG. 3.



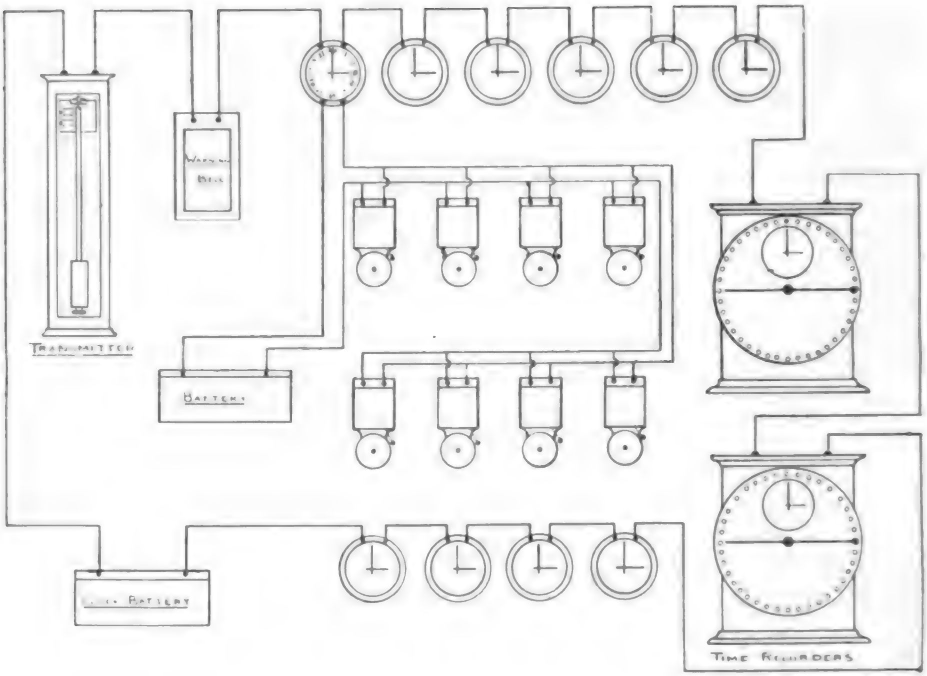
of the pendulum is considerable. The roller and pallet method of gravity impulse allows the gravity lever to be at all times very close to its work, and to be applied at the most advantageous moment.

The application of this gravity impulse to the pendulum is effected in the following manner:— Normally, when swinging with the pendulum, the pallet, H (shown in diagram No. 3), passes close under but does not touch the roller, I, of the gravity-lever, J. At each half-minute, however, the pawl, K, engages the deeper cut tooth, L, of the scape wheel, N, and enables the pawl extension, K_1 to engage the supporting catch, N_1, at the point, N_1 (instead of passing through the stirrup, N_2), and so releases the gravity lever, J, from the catch at the point N_3. The gravity lever being freed, the roller, I, drops on to the "dead" face, H_1, of the pallet, H, and on rolling down the incline, H_2, of the latter, imparts to the pendulum the impulse of constant force. This impulse is completed by the gravity lever being definitely arrested by the platinum surface, O, meeting the platinum surface P. The circuit being completed through their surfaces, the magnet, R, R_1, becomes instantly energised, and the gravity lever is lifted to its (original) potential position by the armature, S, the circuit being again broken by the contact-breaking screw, T. The current which flows for an instant through the magnet, R R_1, also flows through a circuit or circuits containing impulse clocks, turret clock controls, or other apparatus, such as workmen's check clocks, which it may be desired to operate by the periodical half-minute impulse. Diagram No. 4 shows such a circuit, in which are operated impulse clocks, workmen's check clocks, also a number of bells which are automatically rung (by means of contacts within one of the clocks) at the times of starting and stopping of work in factories, &c. The warning bell shown in the diagram is one of the features of the system. This bell gives audible warning when the battery is weakening—long before the battery would fail however—thus preventing a stoppage of the system through a failing battery.

The transmitter, when controlling a turret clock, is usually fixed at the base of the tower or similar low-level position where it can easily be reached for occasional regulation, and this does away with the need of mounting the steps of a tall tower. This low position also gives the advantage that the transmitter is not subject to the vibrations often present in a higher position in the tower. It will be readily recognised that to be able to fix the time-keeping mechanism in the most suitable position for good time-keeping, regardless of the position of the large clock, is an advantage which cannot be overlooked. It will also be recognised that with this electrical system of driving the hands, a large turret clock with exposed hands can be easily made to keep time to a degree of accuracy hitherto only associated with astronomical regulators. Electric striking and chiming can also be added which is entirely automatic in its action, and there is no limit to the size of the bells which may be struck. The whole of the apparatus is worked off Leclanché cells, the current consumption being small, and no winding or attention is required.

A description of this electric time-keeping system would hardly be complete without a short reference to an automatic lighting device, which turns on the gas or electric light (employed to illuminate large public dials) at dusk and turns it off at dawn. The time, however of lighting up may vary from 4.20 p.m. in the winter to 10 p.m. in the summer, with an equal variation of time for the switching off. Seeing that with electric clocks there is no longer need to ascend the towers for the purpose of winding, it would be a pity to have to do so each week just to reset the times of lighting up and

FIG. 4.



turning off. By an ingeniously-arranged cam, however — which by means of simple reducing gear revolves only once in two years — the times of lighting and extinguishing are altered automatically. The error due to leap years is so nearly allowed for, that the error remaining is only 10 minutes in 30 years, and at the end of this period can be corrected and reset for a subsequent period of 30 years in less than one minute. This device is the invention of I. H. Parsons and A. E. Ball, the patentees of the various clock apparatus described above.

CHINESE AGRICULTURE.

The last official census gives the population of the Chinese Empire as 430,000,000, covering an area of 4,278,352 square miles, and whilst the vast area is sufficiently great to accommodate comfortably the population, if properly distributed, many are driven, on account of climatic conditions and agricultural advantages, to certain districts, while the localities lacking in natural conditions that would ensure an existence, are practically deserted. China is an agricultural country, and more than two-thirds of its vast population are engaged in agricultural pursuits, but following a system that was in vogue centuries ago. Increased crops are not the result of advanced cultivation, or the application of modern devices to enrich the soil, favourable climatic conditions alone stimulating the yield. The implements of centuries ago are being constantly duplicated, and while, in some instances, a modern farm implement is brought into service, its reception is not cordially welcomed. While China's population is entirely dependent upon the earth's natural food productions for existence, the knowledge of agriculture seems to be limited to growing only a few things. This may be due to the lack of fertilising facilities, this branch of the farmer's work being such as to make it practically impossible for foreigners to use their products fertilised under the prevailing system. The American Consul at Nanking says that truck gardening, rice growing, and the cultivation of the silkworm form the practical work of the interior, but the land contiguous to the lakes and rivers is almost all unoccupied and uncultivated. The rice of the interior is the universal food, and varies in quality and production in accordance with the climatic conditions of the season. There is said to be no doubt that proper care given to wheat growing in China, as well as to other grains, would greatly enhance the product. The vacant lands drained by the great lakes and rivers, could, with proper cultivation, be converted into wheat-growing farms. The same could be done with the more elevated lands of the interior. It is said that there are about thirty-five flour mills in the empire, producing 1,500,000 barrels of flour, which, of course, come into direct competition with the foreign-made article, and which as time goes on will some day develop into satisfactory proportions. In the north-west of Kansu, which province is considered among the most fertile in China, wheat of fine quality is harvested. In Lower Yunnan the product is large

and satisfactory. In the provinces of Kweichow, Quantung, Fokien, Chekiang, and others, wheat of a fair quality is grown. While in certain parts of China grapes are grown and a sort of wine made from the juice, it is not of such a quantity or quality as to invite attention. The native spirit, which is highly intoxicating, is made of the juice of rice and millet, with the addition of some native ingredient. The textile plants are numerous in China, embracing hemp, China grass or ramie fibre, and cotton. Silk is the product of the worm fed on the mulberry tree; paper is made from the pulp of the bamboo, the fibres of which are used for cord or string. Oil is obtained from a native tree, and is called "wood oil." Oil is also made from cotton and rape seed, ground nuts, &c. The opium poppy, while decreasing under the influence of Imperial decrees limiting its cultivation, is yet a highly important element of soil production, and ranks in this respect with cotton, tea, sugar cane, and bamboo. The Chinese national beverage, tea, is of various qualities, the better and more delicate being the first crop on the sprout. It is harvested three times a year, and the leaves are prepared as black, green, brick, and dust tea. The brick tea is almost all exported to Russia and Mongolia; the other kinds are sent to the United States and Great Britain chiefly. The Chinese serve their tea in covered cups, the cover being of a saucer-shaped arrangement, which can be sufficiently tilted to admit of sipping, after which the cover is replaced. While the apparent blight of China is the absence of forests, unless it be in wild remote parts, there are some valuable trees. Among those producing a marketable substance may be mentioned the wood oil tree (t'ungtz shu), the gum-lac tree (ts'ihtz-shu), the tallow tree (kuentze-shu), the wax tree (pehlah-shu), the camphor tree (tsao-kioh-shu), the soap tree, &c. The mulberry tree, which contributes so much to the leading industry of China, is cultivated for its leaves, on which the silkworm is nourished. This latter industry is of great importance, and the manner of breeding and rearing the silkworm is one of the most interesting studies in China. These trees are plentiful in the provinces of Kiangsu, Chekiang, and Szechw'an. In other provinces another variety of the silkworm thrives on the wild-oak leaves, but the better quality subsist on the mulberry leaves. The greatest blessing in the matter of natural productions that exists in China is the bamboo. It is thought that over sixty varieties of bamboo exist, and it can properly be termed the national plant. It is applied to domestic, commercial, and industrial uses. Its shoots are a great delicacy, and are among the dainty and expensive dishes that usually grace the tables of the Chinese mandarins. Its roots are turned into canes, while the tapering spire is used in making masts, poles, tables, stools, chairs, chop sticks, pipes, umbrellas, fans, musical instruments, &c. The fruit trees of China are the peach, apricot, plum, apple, orange, banana, pineapple, mango, chestnut, persimmon, &c.

HOME INDUSTRIES.

Earnings and Hours in the Clothing Trades.—The report just issued by the Board of Trade as to the earnings and hours of labour of workpeople employed in the clothing trades in 1906 (Cd. 4844) contains much valuable evidence as to the exploitation of women's labour. Reference was made in these Notes last week to the Trade Boards Bill, about to become law, which empowers the Board of Trade to establish *minimum* rates of wages in the ready-made tailoring trades and others in which there is reason to believe that wages are exceptionally low, and the facts collected in the present report supply additional evidence of the sweating common in these trades, more especially among women workers. This evidence relates not to home workers but to operatives employed in factories and workshops who, poor as their wage often is, are paid a higher wage than the home worker. The men employed in the clothing trades do not seem to have much to complain of: indeed, as compared with the textile trades, the wages of the men appear to be 2s. a week higher on an average, the number earning less than 20s. a week being only 7·2 per cent. as compared with 18·4 per cent. in the textile trades. It is the women who are the sufferers. There is great uniformity in the average wages in the different trades, 11 out of the 16 trades dealt with showing an average of between 12s. and 14s. a week, but whilst there is great uniformity in the average wages of women as between trade and trade there is great diversity in the wages paid within the different trades. For example, in the dress, millinery, &c. (workshop) trades, 15 per cent. of the women earned over 20s. per week and 28 per cent. earned less than 10s. a week. The report gives a summary showing the earnings of women classified in four groups, those earning less than 10s. a week, those earning between 10s. and 15s. per week, those earning between 15s. and 20s. per week, and those earning 20s. per week or over. The majority in most of the trades earn between 10s. and 15s. per week, but 21·6 per cent. of all the women employed in the clothing trades earn less than 10s. per week, and that only when working full time. The highest percentage but one in this class is paid in the dress-millinery, &c. (workshop), where 28 per cent. of the workers earn less than 10s. per week, the average earnings for full time being 13s. 10d. per week. The highest percentage is in the corset (factory) class, where it is 28·8, and the average earnings for full time is the lowest of all, 12s. 2d. Fur stands best, the percentage of women workers getting under 10s. per week being only 9·4, whilst 27·2 per cent. earn 20s. and over, and the average earnings for full time amount to 16s. 7d. per week. The low wages indicated above are not to be taken as applying only to the clothing trades. In the textile trades, as was shown in these Notes recently, the wages paid in many branches are lower than in many branches of the clothing trades. Low wages, so far as women are concerned, are common to all, or nearly all,

trades, one of the reasons being that the women employed are usually partly supported by others. The report gives a Table showing the average annual earnings per head in 1906 of the workpeople employed in the clothing trades. Earnings vary from £29 in laundry workshops to £58 10s. in the fur trade, but the averages relate to the earnings of all the workpeople employed, and there are great fluctuations in the numbers employed owing to the seasonal character of many of the industries. A section of the report deals with the hours of labour, and shows that, including meal times and overtime, the hours for a full week vary from 50·8 in dress-millinery, &c. factories and bespoke tailoring to 56·8 in the silk and felt hat industy.

The Harvest.—The harvest of 1909 may be described as an abundant one much damaged by the weather. After a splendid fortnight the weather broke on August 17th and has been unsettled ever since. Much corn is still out, and much of it has been hurried into rick, so that a great deal of wheat is necessarily in poor condition. The barley crop is believed to be the heaviest grown during the last ten years, with the exception of 1906, but it has been much knocked about by the weather, with consequent damage to its quality, and it has been impossible to cut much of it by machines. The oat crop greatly improved in August, but there are striking differences in its condition. Taken as a whole it is somewhat better than last year, but not so good as the crop of 1907. Beans are the worst crop recorded since 1904, and have suffered much from black fly, and the pea crop is poor, having developed too much haulm. Potatoes are suffering severely from disease in some districts, and in all from the cold and moist character of the season. The root crops are exceptionally good, but the weather has been too cold for mangel-wurzel. The hop reports are more favourable than they were in August, but there is a sad collapse as compared with the position at the beginning of July.

The Whisky Trade.—One of the many industries affected by the Budget proposals is the whisky trade. The increase in the duty of 3s. 9d. per gallon has necessitated an increase in the price of proprietary blends of Scotch whisky by at least 6d. a bottle. This has created a new set of conditions in the distributing branch of the Scotch whisky trade, and, owing to the demand for whisky at the old price has intensified competition. This result has quickened the disposition of the three companies who are the principal distributors of blended whiskies in bottle to consider the possibility of amalgamation. There is a good deal to be said in favour of this course. Each of the three companies has created an immense and world-wide business largely by means of advertising, but the cost has been very great, and competition generally is growing in intensity. Amalgamation of the three companies should mean reduction of clerical and travelling staffs, raw material got upon easier terms, and considerable reduction of advertisement charges. All three companies' control distilleries whic supply a large portion of their needs, but they remain large buyers of single whiskies on the open market, and amalgamation should make them more independent of outside supplies. It is true that at present they can buy old Highland malt and other whiskies at prices little above the original cost, but this is due to the mad over-production of the distilleries in past years, and, as their production has been largely curtailed, stocks are being gradually reduced, and before very long should again be in proper proportion with consumption. Blenders will then have to pay more for their supplies, and it would be to their advantage to be less dependent upon outside sources.

Cutting Coal by Machinery.—In the United States, where the coal seams are favourable to the employment of machinery, machine cutting at the collieries has made great progress in recent years. In the American bituminous mines, as recently as 1891, the proportion of machine-mined coal was only about one ton in fifteen, say 6·66 per cent.; fourteen years later the proportion was 33 per cent., and every year sees the percentage grow. In the United Kingdom, the use of the machine cutter has been much less common, but here, too, it is now making headway. In 1902 there were only 483 machines at work in the whole country; in 1908 the number had risen to 1,659. In 1902 the machine-mined coal was something less than 4,000,000 tons, last year it reached 13,508,510 tons, and it may be taken that the Eight Hours Act will add largely to the use of the machine. At present it is used more commonly in East and West Scotland than in England, the percentage of machine-cut coal in East Scotland in 1908 being 14·2 per cent. In England, Yorkshire uses the machine more than any other district, the percentage being 8·1, but it is noteworthy that although last year there was a lessened total product of coal—261,528,795 tons, as against 267,830,962 in 1907—the machine-mined coal increased from 12,877,035 in 1907 to 13,508,510 tons. Outside Scotland, compressed air is preferred to electricity as the driving power. In 1908 more than 46 per cent. of the electrically-driven machines were in use in Scottish collieries, and statistics show that so far as England is concerned compressed air is more than holding its own, the belief being that it is a much safer power than electricity to use for coal-cutting in seams liable to fire-damp.

The Growth of Temperance.—The figures given by the Chancellor of the Exchequer in the House of Commons a few days ago show that the shrinkage in the use of wines and spirits continues. Taking the duty paid on wines in August of the three years 1907-9, the contraction is shown in the following figures which represent the duty paid during August of each of the years named—£74,000; £65,000; £62,000. It will be remembered that the

Budget of the present year makes no difference in the wine duties. Turning to the duty paid on spirits in the same month in the same three years the figures are £1,600,000; £1,477,000; £1,263,000. The heavy drop in August was largely due, no doubt, to the enhanced prices. The effect of the rise in prices is still more noticeable in the consumption of beer, which showed some increase in August, 1908, the duty paid in that month being £1,255,000 as against £1,228,000 in the same month of 1907, but in August, 1909, the amount fell to £1,128,000. The rise in the retail price must have had a good deal to do with the shrinkage.

EMPIRE NOTES.

Openings for British Capital.—These are many and important in every part of the British dominions. Take, for example, the opportunities offered by the extension of the Grand Trunk Pacific line to Prince Rupert, on the Pacific coast. During the present month, twenty-one town sites along the main line of this railway, West of Edmonton, Alberta, are to be put up for sale. According to the report of Mr. G. V. Ryley, Land Commissioner, it is scarcely twelve months since a series of town sites were placed upon the market, and already over 500 lots have been sold, all of them at very good figures, and the sales are rapidly increasing. These towns are located in a wealthy agricultural district, which is already peopled with settlers, and which, on the completion of the line, has in it the promise and prospect of great expansion. Many of these towns are admirably situated on lakes and rivers. Similar opportunities are afforded in Australia and New Zealand, where the extension of the railway systems of these countries is opening up vast areas of land, suitable for agricultural settlement. But these are only illustrations of the present opportunities offered by the Colonies for the profitable investment of capital.

Openings for British Settlers.—Whatever may be said about the difficulties surrounding the question of emigration, no one doubts that our oversea States, if they are to be developed and adequately defended, need a large and rapidly-increasing population—a population which should be drawn mainly from the British Isles. Canada fully realises this need, even while she is wisely exercising care as to the character and suitability of the immigrant she is receiving. In the adoption of this policy of selection, the Dominion Government is only acting on the lines of the United States authorities, who, by their drastic system of enquiry and examination, are seeking to stem, as best they can, the influx of "undesirables"—a system which, if it were employed by any one of our own oversea possessions would raise a storm of criticism and indignation. But, while exercising care in selecting the proper class of immigrant, Canada is doing her best to people her broad lands, and for this purpose she is welcoming not only people from this country, but large numbers of Americans, many of whom however, originally settled in the States from Canada. These are recognising the advantages the Dominion offers, and are taking up extensive areas in the prairie provinces. At the same time, by diligent propaganda on the part of the Dominion and Provincial Governments, the Canadian Pacific and other great railway lines, Canada is endeavouring to secure settlers from the British Isles. Australia, also, is beginning to recognise the absolute need of increased population, but the efforts she has put forth, thus far, are too limited and spasmodic to allow of any great success. It is true that some of the Australian States appear to be drawing largely from other States, according to the superior advantages for immediate settlement they are able to offer, but this, of course, does nothing to increase the population of the Commonwealth, as a whole. A new departure, however, is likely to be taken when the High Commissioner is appointed and the proposals for inter-State action, which have been tabled by Mr. Deakin, the Prime Minister of the Federal Parliament, have been considered and adopted.

Proposed Imperial Conference on Migration within the Empire.—Whatever separate arrangements the Colonies may make in regard to immigration, it is becoming increasingly necessary for all the authorities concerned, both home and colonial, to confer together on the whole question of migration within the Empire. Suggestions to this effect have frequently been made, but hitherto without avail. In view, however, of the recent Conference on Imperial Defence, in which the question of population is one of the most important factors, and of the necessity of dealing, at the same time, with our surplus population, and with the grave problem of unemployment, the time is opportune for further efforts to be made in this direction. Both in the interests of defence and trade, it is of the highest importance that Imperial action should be taken. Dr. Richard Arthur, of Sydney, the President of the Immigration League of Australasia, in a lecture delivered under the auspices of the Royal Colonial Institute, on "Imperial Emigration and its Problems," in May last, said:—"The subject of preference in trade is, undoubtedly, an important one, whatever view may be taken of it, but the best way to encourage trade between the Mother Country and the Colonies is to increase the population of the latter. Every person in Australia, New Zealand, and Canada, bought respectively, last year, goods to the value of £6, £8 10s., and £2 from the United Kingdom, in striking contrast to the United States, which took merchandise from the United Kingdom to the extent of about 5s. per head of population; Germany and France about 10s. per head, and the Argentine about £1." In the light of this fact, there can be no question as to the wisdom of encouraging the settlement of people, especially our own people, in our own oversea States, as, by so doing, we shall largely increase that Imperial trade which it should be our object to promote.

Manufacturers' Day in Victoria.—In order to encourage federal industries, Australian-made goods only were displayed in the shop windows of the cities and towns of Victoria on the 3rd inst., on what has been called "Manufacturers' Day." The movement appears to have been heartily taken up, and it is claimed, has given an impetus to the sale of locally manufactured articles. This step is an interesting indication of the desire and determination of Australia to produce for her own market, although, from an Imperial point of view, it has its unfavourable side, as imported British manufactures, as well as those from foreign countries, were excluded. Still, it is well for the British exporter to realise that Australia means, as far as possible, to develop her local manufactures. The character and strength of this determination are illustrated in the recent returns as to the number of factories in operation in Victoria in 1908 compared with 1904, and the relative increase of factory workers and value of output. The number of factories has increased 10 per cent., of *employés* more than 20 per cent., and the output has grown from 23 millions sterling to 30¾ millions.

Conservation of the Natural Resources of Canada.—A permanent Commission, consisting of thirty-two members, has been appointed for the purpose of securing a definite policy for the conservation and better utilisation of the forests, water power, minerals and other natural resources of the country. This appointment is the result of the International Conference held at Washington in February last on the general question of the Conservation of the Natural Resources of America. The members of the Canadian Commission will represent the Dominion Government, the government of each province, the universities, and the leading industries concerned.

NOTES ON BOOKS.

THE COLORIST. By J. Arthur H. Hatt. New York: D. Van Nostrand Company. 6s. 6d. net.

Mr. Hatt states on his title-page that his book is "designed to correct the commonly held theory that red, yellow, and blue are the primary colours," and in his preface he refers as the latest authority on the subject to "a French gentleman, M. E. Chevreul, a manufacturer of dyestuffs," who "made an extensive series of experiments with colors." The value of the work of this most distinguished chemist is of course fully recognised; but it is also perfectly well known that its present value is lessened by the fact of its being based on Brewster's old theory that the three primary colour sensations were red, yellow, and blue. Of course the Young-Helmholtz theory has long since superseded that of Brewster, and is familiar to all students of the subject, however elementary their knowledge. But the writer of this work does not seem to appreciate that while the theory that there are three primary colour sensations appreciable by human sight is accepted, there can be no possible justification for speaking of any colours as being primary in a scientific sense. On the other hand it is a perfectly convenient nomenclature either to call red, green, and violet primary colours, since by suitable mixtures of these three hues, any other tint can be produced capable of appreciation by the human eye; or else to call red, blue, and yellow primaries, since by suitable mixtures of pigments of these colours, the artist, or the colour printer, can in the same way produce all the tints that he requires.

The author also is quite mistaken in supposing that there is any want of a good text-book on colour based on the most recent scientific principles. It would be easy to mention several.

A useful suggestion is made by the writer that a whirling-table, and a set of suitable coloured discs, might be used for practical purposes for the reproduction and matching of any required colours. But the first difficulty is that practical people are not prepared to agree upon a standard series of colours; while there are a good many minor difficulties arising from the differences of the texture of materials. The suggestion was indeed made some years ago by Sir William Abney, who also pointed out that if a standard series of tints could be agreed upon, it would be possible to reproduce them by the mixture of certain selected rays from the spectrum, and these tints could be conveniently reproduced at any time, when the numbers indicating these rays were given. For commercial purposes, however, the difficulty of differences in texture would still exist, and the standard series of colours is yet, and is likely to remain, unsettled.

DRAWINGS FOR MEDIUM-SIZED REPETITION WORK. By R. D. Spinney, A.M.I.Mech.E. London: E. and F. M. Spon, Ltd. 3s. 6d. net.

The notes of which this little volume is composed, are chiefly intended for engineers who wish to supervise the preparation of drawings made for the guidance of men engaged in repetition work, *i.e.*, the making of similar parts of machines in considerable quantities. In order to simplify his task, the author has thought it advisable to restrict his example to parts of motor-cars, but the student who has learnt how to deal with these should have no difficulty in applying his knowledge to problems in kindred branches of engineering. The word, "drawings," is taken by Mr. Spinney to cover "the visible result of the draughtsmen's labours, and includes the fullest instructions for the buying and making of the component parts of the machines:" thus, we have sections on such subjects as—rules for a drawing office staff, standardisation by means of lists, standardisation of clearances, methods of indicating tolerances on drawings, division of costs between material, labour and special tools, &c. The book is full of very practical information, and gives a comprehensive but succinct account of the work of the drawing office.

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INDIAN SECTION.

THE MAHRATTA PLOUGH.

By Sir George Birdwood.

PART II.

The Plough.

Doth the plowman plow all day to sow? * * * Doth he open and break the clods of his ground? When he hath made plain the face thereof * * * doth he not put in the wheat in rows, and the barley in its appointed place, and the spelt in the border thereof? For his God doth instruct him aright and doth teach him, Is the bread corn ground? * * * This also cometh forth from the Lord of Hosts, which is wonderful in counsel and excellent in working.—Isaiah xxviii., 24-29.

When engaged in the contemplation of the creative power of the Almighty as manifested in the geography and general physiography of the Mahratta Country, we are apt momentarily to regard merely human affairs and interests as altogether insignificant and contemptible; and to exclaim with the Hebrew Psalmist:—"What is man that Thou art mindful of him? and the son of man that Thou visitest him." And yet when we come to examine the wonderful ways in which the Mahratta *rayat*, or cultivator, has adapted himself to his surrounding conditions of soil and climate, and gradually secured his economic mastery over them, it seems to us again as though the Almighty had contrived them to no other end than to subserve the purposes of man; and as if indeed the Godhead's Self was one with Nature, or the Divine Reason residing in the whole world, and in its parts, and adjusting and determining them all to the abiding well-being and highest happiness of humanity.

Between the reaping in January and February of the *rabi* [literally "spring," otherwise called "the cold weather" and "the dry weather"] crop, consisting chiefly of wheat, barley, grain, peas, lentils, and safflower, sown in October and November, and the sowing in June and July of the *kharif* [literally "autumnal," otherwise called "the summer"

and "the rain"] crop, consisting of *jawari* [Sorghum vulgare], *bajri* [Penicillaria spicata], rice, maize, and numerous species of country pulse, and *til* [Sesamum orientale], all reaped in October and November,—in this fallow interval between February and June, the central plain of the Dakhan assumes, particularly during the sullen stillness of the direct and the reflected solar heat from 11 a.m. to 3 p.m., a scorched and desolated appearance; a yearly recurring memento of the ominous fact that Southern India after all lies within the solstitial, and therefore desert zone of the northern hemisphere; and that only by a wide promotion by the State of scientific forestry, and of irrigation works, such as dams along the natural lines of the trap dykes crossing the rivers, and by assiduous cultivation on the part of the *rayat*, can even the Mahratta Country, beyond the immediate shadows of the Sahyydris, be made certain of an adequate rainfall and water supply, and secured against famine. But all is changed, as by some supernatural spell, with the first fearful deafening appeals of the burst of the Monsoon, and the furious downpour, amid sudden gleams and flashes of lightning, and ceaseless reverberations of thunder, of the divinely odorous* and revivifying rain. In a single night, as I have known it happen at Kaladghi and Sholapur, the parched earth of the four previous months turns to the tenderest, liveliest green; rivalling in softness of texture, and outvieing in vivacity of hue, the azure of the now refreshened skies outstretched above. And when the blossoms of this, the true Indian spring, begin to appear upon the green expanse, and, trembling like stars in every breath of air that stirs across them, first unlock their painted petals, white, and red, and blue, and yellow, and purple, to the expectant day, beholding them, one feels that there is no pleasure under heaven equal to that of looking upon bright, fragrant flowers, fresh blooming in their native fields; and wonderful as is the revelation of the forest vegetation of the Sahyadris, the charm is still greater of the enchanting inflorescence of the vernal Dakhan plains.

A few weeks later, and round all the hamlets and villages, or rural townships, and the palatine and sacred cities [Civitates Neocoræ] of Maha-rashtra, as far as the eye can reach, the fields are already everywhere swelling high with pulse and cereal grains, oil seed, and fibre and dye-yielding plants, sown for the autumnal harvest.

Pliny tells a story of a Roman freedman, who having found himself able from a very small piece of land to raise a more abundant harvest than his neighbours could do from the largest farms, was accused of enticing away their crops by sorcery; when, pointing to his firmly-hafted mattock, and stoutly-bound plough, and sleek oxen, all of which he had collected in his defence before the magistrate: "Here, Roman citizens," he cried, "are my implements of divination; but it is impossible for me to exhibit to your view, or to bring into this Forum, those midnight toils of mine, those early watchings, those sweats, and those fatigues." It is the perfected indigenous plough of the country, the product of three thousand years experience, and the master's eye everywhere, that not once, but twice in each year, brings about the same magical results in Maha-rashtra, and, I might add, throughout India.

Some nine or ten [now 29-30] years ago Sir Philip Cunliffe-Owen had photographs taken of the native ploughs in the India Museum at South Kensington, for the purpose of enabling a leading firm of English agricultural mechanists to manufacture similar ploughs for use in this country.

They really need not have gone so far as India for improved ploughs for light soils, and small peasants' holdings, for the single stilt plough in use in the Shetlands is identical with the native plough used in the Dakhan. The foot-plough, *casehroom*, of the Hebrides, is yet simpler; and it is probably the simplest plough now known; and comparable in Europe only with the αὐτόγυον* of the Greeks. It can be carried on a man's shoulder, or under his arm, when he goes forth to his work in the morning, and returns therefrom in the evening; and it would be really more useful than any Indian plough in the cultivation of the small patches of arable bog-land in Ireland.

I believe it was also the hope of the English firm to undersell the native manufacturers of agricultural implements in India. It was an evil hope, but, fortunately, also a vain hope, for there is no chance of its ever being fulfilled. In India the cultivators manufacture their implements almost entirely themselves. In the Mahratta Country the *rayat* makes up the whole of the plough himself, except the iron work on it. This is prepared separately, and

* "Et cum a siccitate continua [terra] immaduit imbre; tunc emittit illum suum halitum divinum, ex Sole conceptum, cui comparari suavitas nulla possit."—Pliny, xvii. 3 (5).

* Compare Virgil, "Georgics," I, 170:—"et curvi formam accipit ulmus aratri."

so adjusted to the wood work that, after the days' ploughing is done, the *rayat* removes it, and carries it home with him every night. This iron work is all for which he pays directly "out of pocket;" and the price of the whole plough, wood work and iron work, is from 2½ to 3 rupees, *i.e.*, 5s. to 6s.* The cost of the native drill plough is from 5s. 6d. to 6s. 6d., including the wooden receptacle [carved with figures of the merry-hearted rural gods, Hanumant or Krishna], into which the seed in sowing is poured. No English manufacturers, here or in India, will ever make ploughs below these prices. In the Mahratta Country, a slighter plough is also used for the light ferruginous soils of the *mavals*, and a heavier for the deep-stapled black soil of the *desh*; but everywhere these two ploughs are made convertible by means of a weight, that can be fastened to or removed from the ham of the plough. There are also two kinds of drill ploughs, one used for sowing safflower and gram, and the other for sowing *bajri* (Penicillaria spicata), and *urud* (Phaseolus radiatus). The Indian bullock hoe is most effective for cutting up the stalks and roots of plants and loosening the earth wherein they have grown. It invariably follows the drill plough to cover in the furrows sown by the latter.

The application made by these English manufacturers to Sir Philip Cunliffe-Owen is, however, most interesting and instructive, as showing that even in agriculture England has lessons to learn from the natives of India. I had great practical experience in flower, fruit, and field cultivation all the time I was in Bombay, and always took the most intimate interest in the ways and means of native agriculture; and I am convinced that all the doctrinaire outcry against it, from the days of Tennant and James Mill downwards, as unscientific and wasteful, is as ignorant and insular as is the stereotyped depreciation of the industrial arts of India, by the same writers, and in the reports on the earlier International Exhibition held in Europe.

This is not the occasion for entering into any lengthened chemical statement on the subject, yet I would wish briefly to set forth here some of the more striking facts in proof of the exhaustless richness of the Indian soils, and the perfected science of Indian agriculture. There is no manure known more fertilising than March dust. Its fruitfulness is proverbial. *In India we have this March dust blowing everywhere all through the year.* In the Dakhan the deep-stapled black cotton soil is ploughed through and through to the bed rock below it by the wide gaping cracks formed in it during the hot season, from February to June. So soon as these cracks are formed they are filled with the fine blown dust which loads the winds that all day long, and all through the night, sweep the whole country. And as soon as the cracks are filled, new ones form again at once; and thus the soil is kept in a perpetual state of almost molecular disintegration and movement, and is ceaselessly reoxygenated by these simple, natural processes, to its lowest depths.

The trap rocks forming the substratum of the Mahratta country abound in quartzose and zeolitic crystals, containing all the mineral constituents necessary for the renewal of arable soils. I have seen millions of tons of these crystals heaped up on the weather-worn eastern slopes of the *ghats* about Yevut and Patus. There they lie, baking and cracking in the sun, and eroding in the wind, during all the hot season; and when the overwhelming rains follow they are rolled for hundreds and hundreds of miles along the beds of all the rivers that pour down from the *ghats* across the Dakhan to the Coromandel Coast; and with their flood waters spread the finely lixiviated fertilising dust into which the crystals are ceaselessly ground and comminuted far and wide over all the plains of the Dakhan. The black "Cotton soil" of India, needs, in short, for ordinary field cultivation, no other manuring than that which in this way it receives from the open hand of Nature. Yet there is always in every village plenty of the best material for artificial manuring, where it is needed, in the deposits formed in the village tanks. It is in constant use for garden cultivation. *But in truth the whole soil of the Dakhan is in a sense tank deposit.* The trap formation of Western India slopes, as has been shown, from west to east, like a shelving beach, and crops above the general surface of the Dakhan in a succession of reefs, running at right angles to the eastern spurs of the Sahyadris, between the Malabar and Coromandel coasts; and the staple of the soil of the Dakhan was originally deposited from the succession of fresh-water lakes, formed by the rain water falling on the Sahyadris between their eastern spurs, and pounded back by these longitudinal trap dykes; lakes which at one time covered the greater part of the surface of Southern India. When the rocky barriers were at last forced,

* At the rate of exchange during my time in Bombay.

the waters of the lakes drained off into the Bay of Bengal, through the channels now marked by the courses of the Godavari and the Kistna; leaving the plain of the Dakhan covered to the depth of often thirty and forty feet, with its exhaustless arable soil. One can always trace where these rents have taken place by the great breadth of arable land behind them, and the sudden contraction of the bed of the river, which often at these points flows with a peculiar noise as between closing flood-gates. The village of Gulgula, near one of these rents in the course of the Kistna, just beyond Mudhol, derives its name from this noise. It is the same word as "gurgle" and "gargoyle," and as Gilgal, the name of two or three places in Palestine, and of Silsilis [the soft Greek form of the Arabic Jiljilleh], the name of an ancient town on the Nile, near a rocky barrier in the course of the river that was burst by the lake once existing behind it within historical times.

I am referring, of course, to the historical black soil of the Dakhan, not to the red; the specific "Cotton soil" of Anglo-Indians, and the *regur* of the Hindus. In this word the syllable "*ur*," *i.e.*, "*ar*," is probably the same root, referring originally to ploughing, that in so many Indo-European languages enters into words connected with agriculture, and the ideas and institutions derived from agriculture, such as "arvum," "aratum,"* &c., &c., harvest, altar, area, arable, aristocracy, &c. It is the root of the word Arya. *Reg*, *i.e.*, *rig*, is the same word as the Scotch "riggs" (entering also into *Rig*—[Veda], "regular," &c.), or the lines of heaped up earth formed in ploughing. *Regur*, therefore, radically means simply "arable," and this ancient Hindu designation of the "Cotton soil" of the Dakhan is an incidental proof of its immemorial reputation for fertility.†

There is also another unmistakable proof of its inherent fertility. Pliny, in enumerating the different qualities of arable soil, pretty much in the same way as we find them enumerated in the Settlement Reports of the Bombay Presidency, and describing the tests for them, points out that the one infallible characteristic of a naturally rich and wholesome soil is "the divine odour" it exhales [v. Footnote, *supra*], when it is first turned up, or when the first dews of twilight fall on it, or rain after prolonged drought. Every one who knows India will recognise that this is the distinguishing odour of the black "Cotton soil" of the Dakhan; and the authentic credential of its being the charmed treasure that assures the fortune, the felicity, and the fame of India.

The Hindus habitually use manure in the cultivation of rice. Some time in the hot season the land is strewed with all the refuse of the homestead,—and floor sweepings, and old thatch, old clothes, *et cetera*, all are burned together on the surface of the rice fields. Then when the rains set in, the ashes from this burning are trodden by the men, women, and children, and by the cows and buffaloes, into the ground, until the whole surface is kneaded into a plastic, cohesive mud, called *chikal*, in which the rice is sown. The effect of burning the manure on the surface to be sown is to bake the ground immediately below the upper layer of fertile mud into an impervious bottom, which prevents the rain from draining through; rice requiring that its roots should be completely covered with water all the time it is growing. In a carefully cultivated rice field, or rather pond, the water of the rainy season, June to September, disappears only by evaporation; and by the completion of this process the grain is ripe for the harvest. More than this; rice cultivation, and brick and pottery making, are almost everywhere interdependent industries in India. The natural crude clay of the soil is too contractile, and too little cohesive for brick and pottery making. It has therefore to be kneaded with ashes before it can be used for these purposes; and in fact it is the *barsat-mati*, or "rain-earth" of the rice fields, always used for the best native bricks, and pots and pans throughout the Mahratta country. The potter is almost always also the rice cultivator of the village. *There could not be a stronger proof than this of the thoroughly practical and scientific character of Indian agriculture*. The simple reason why every attempt by self-sufficient Englishmen to make bricks and pottery in Bombay at first proved a ruinous failure was that crude clay, obtained, as in England, from the first ground to be purchased in the market, was used in their manufacture, instead of *barsat-mati*.

In the Dakhan the fields are never ploughed

* The English name of the plough, the immediate derivation of which is uncertain [v; Skeat—sub plough and plover] refers to the boat, and bird-like shape and movement of the implement itself: going back to a Sanskrit root signifying float, swim, fly, wash, boat, &c.; from which, through the Germanic language, we get the words fly, flock, fowl, float, fleet, &c., and hypothetically plover; through the Latin languages lustre [of 5 years], lotion, lavender, pluvial, &c.; and through Greek [peri-]plus.

† The word *regur* is Telegu and Kanarese, and, as actually used throughout Southern India, means "black-[soil]."

oftener than once in two years, and in some places only once in four or five, and even six years. The surface *regur* does indeed become exhausted by continual cropping without ploughing; but with occasional ploughing, just to turn the soil, and, still more important, to clear away the thick mat of creeping weeds, its fertility is exhaustless, if it is of any staple, and a foot is sufficient. *In a word, regur is itself manure in its final chemical form; and the Sahyadri mountains and their spurs, its original source, may be compared to an everlasting mound of manure, and the Monsoon drainage of them to liquid dressing, by the regular application of which the incorruptible vitality of the regur deposits in the plains below is perennially renovated.*

The *nangar* [cf. "anchora"], or ordinary Mahratta plough, is made up of the six following parts* :—

1. The *dant*,† "dentale" or "dentalia," of the Romans, ἔλυμα of the Greeks, the body of the plough, or share beam of *babul* wood [*Acacia arabica*].

2. The *phal*, "vomis" of the Romans, ὕννις of the Greeks, *sikka* of the Hebrews, the spade-shaped iron share, fastened to the share beam by its long handle [*pahla*], and a triangular iron girdle called *wasu*. It will be remembered that the Roman spade was called "pala."

3. The *ruman*, "buris" of the Romans, γύης of the Greeks, *dakas* of the Hebrews, the upright stilt, or plough tail, fastened into the broad end of the plough beam.

4. The *mutiah*, "stiva" and "manicula" of the Romans, ἐχέτλη of the Greeks, *kabusa* of the Arabs, the cross handle passed through the top of the *ruman*, by which the plough is held and guided.

5. The *alus*, "temo" of the Romans, and ῥυμός [cf. *ruman* above] of the Greeks, *buruk* of the Arabs, the pole or plough tree, by which the plough is drawn.

6. The *juh*, "jugum" of the Romans, ζυγόν of the Greeks, the yoke for the oxen drawing the plough.

This plough can easily be converted from a light to a heavy one by placing a stone weight on the share beam, or by having a second heavier share beam to substitute for the lighter when necessary. A light plough, drawn by two oxen, is used on the acclivities of the *mavals*, but in the *desh* a heavy plough, drawn by four or six, and even eight, oxen is occasionally used.

The drill plough, for sowing at the same time as ploughing, is also of two kinds—the heavier, called the *moghar*, for sowing gram and wheat; and the lighter, called *pabhar*, for sowing millets and other small grains. Both are composed of the eight corresponding parts following :—

1. The *lohr* or roughly triangular transverse beam, which is heavier in the *moghar* than in the *pabhar*.

2. The four *phan* [cf. fangs], or pieces of wood inserted, pointing forwards, at regular intervals at the lower edge of the transverse *lohr*.

3. The four *pharoli*, or four iron tips of the four *phan*.

4. The four *nala* [nullahs], or hollow bamboos inserted by their lower ends through the four *phan*, and opening out on the ground, behind the four *pharoli*.

5. The *charh*, or wooden cup [carved with the images of Hanuman, Krishna-Veshnu, or Siva, or all of them] into the bottom of which the four converging *nala* are inserted by their upper ends; and thus carry off the seed poured into the *charh*, and deposit it through each of the four *phan* in furrows, simultaneously turned up by the four iron-tipped *phan*.

6 and 7. The *dandi* or plough-pole; and the *juh* or yoke.

8. The *ruman* or plough tail.

The whole of the apparatus for sowing, the *char* and four *nala*, is removable, and this plough can therefore, when required, serve as a harrow.

It is identical in principle with the drill plough of Mesopotamia* represented on the black stone monument of the Assyrian King Esarhaddon, B.C. 681—668, now in the possession of the Earl of Aberdeen; and looking at this figure, and considering that lower Mesopotamia was the earliest seat of advanced agriculture, including river damming and canal construction, in Anterior Asia, there can be little doubt of the drill plough of India having originally been obtained from Babylonia. It was probably introduced into Western India by sea, direct from the Persian Gulf; while the ordinary single-stilted plough would seem to have passed from Mesopotamia overland into North-Western India, through Persia.

* Read with this,—Hesiod, "Works and Days," 426 *et seqq.*; and Virgil, "Georgics," I, 161-75.

† The Roman *dentale* was sometimes made up, as in the Mahratta *danti*, of two symmetrical pieces, and its name then took the plural form of *dentalia*.

* It is figured in Canon Rawlinson's *Ancient Monarchies*, ii. 198. Edition of 1864.

The Greeks and Romans must also through their common ancestors have received their single-stilted plough from Mesopotamia; while the later double-handled plough of Europe is to be traced back to the influence of ancient Egypt.*

In the *kulav* or hoe, a long iron scraper, called *phas*, is attached to two lateral pegs called *janavli*, to the transverse beam or *lohr*, into which are inserted the draft pole, or *dandia*, supporting the yoke or *juh*, at its end, and the upright stilt or *ruman*, with its cross handle or *mutiah*.

The remaining draft implements are the *alvat* or *muhig*, a long transverse beam fixed to a pole and used to level down ploughed fields and break up clods; the *jang* or *janjia*, the common husbandry cart, consisting of a large wicker work basket-like body, set on solid hewn wooden wheels, and used for carrying weeds, rubbish, and manure; and the *gara*, consisting of a flat light frame, of four long longitudinal planks, fixed by three shorter transverse planks, set upon solid wooden wheels, and used for carrying produce—the "Tardaque Eleusinæ matris volventia plaustra," of Virgil, "Georgics" I., 163. The cost of the *gara* is Rs. 100, and it is the most expensive article of rolling stock in a Dakhan farmyard.

The chief hand implements are the *yila* or sickle, and the *koita* or bill-hook, and the *kudal*, *kudli* or pick; and so perfectly adapted are the forms of these implements to the work to be done with them, and so true the steel used in their fashioning, that in the work of the Victoria Garden, Bombay, I had to prefer them to the best American and English-made gardening tools. This is a complete list of the moveable plant required in the cultivation of the Dakhan soils.

The cut grain is stacked before threshing, and is threshed by being trodden out by oxen on some near spot, made smooth by damping it with water, and beating it down, and cow-dunging it, and allowing it to dry in the sun. A pole [*tevrah*] is then stuck in the middle of this open air floor, and six or eight bullocks, half on one side of the pole and half on the other, are driven round and round it, until all grain is tramped out; and the stalks crushed into a friable fodder much relished by the cattle. The winnowing or *upun* is done upon a winnowing basket [*upun-vati*], identical with the "mystica vannus Iacchi" of Virgil*; and the grain is then stored in baskets, called *kuning*, made of the twigs of the sacred *nirgand* [Vitex Negundo], and thatched over the top, like old-fashioned beehives, or in earthenware jars called *hotli*, of very archaic form and decoration, being square at the top and bottom, but bulged out between, and marked round the neck with bold notches, or a rope-like moulding. When the grain is wanted for household use, it is ground by the women in a hand-mill called *chaki* ["wheel"] consisting of two round stones, one turned on the other by a wooden peg fixed in the rim of the upper stone; through a hole in the centre of which the grain is poured in between it and the nether stone. Husked grains, such as rice, and some of the smaller millets, are pounded in a mortar called *ukal* with a pestle called *musal*. The latter is a straight piece of wood four or five feet long, tipped at the bottom with iron, and at the top with a round knob, cut on the stick itself. The mortar is of wood, shaped like a truncated hour glass, and notched archaically round the constricture of its body.

This exhausts the distinctive properties—the whole "arma Cerealia"—of a Dakhan *rayat's* farmyard; but in every considerable village there is sure to be found an oil mill, and a sugar-cane press; and among the surrounding fields and plantations one or more wells [*vihir*], with their high-raised, overhanging apparatus of running wheel, and folded large leather bucket, of about sixty gallons' capacity, for raising the water, and sending it flowing through a thousand tiny channels over all the adjacent acres of lush and swelling vegetation. They present one of the most characteristic sights round an Indian agricultural township; and nothing can be more delectable in the noontide of the cold season than to listen to the hardy, manful Dakhan *rayats*, stripped naked to their work, singing joyously at these wells, to the sweet, and enhearting musical accompaniment of the water ceaselessly outpouring from them into a widely murmuring maze of rippling rivulets and rills.

Add to these out-of-door properties the appliances to be found indoors, — the large earthenware or brass lamps, the jars for holding meal, spices, and condiments, the pestle and mortar for bruising them together, the kneading board and a rolling-pin for preparing the unleavened cakes of *bajri* and *jawari*, the

* Pliny, vii. 57 (56) writes: "We owe the use of oxen and the plough to Buzyges (*i.e.*, Ox-yoker) the Athenian; but others say to Triptolemus."

* "Georgics," I., 156.

iron girdle for baking, and the copper pots and pans in which the *bajri* and *jawari* porridge, the pulse porridge and pulse soup, and the spiced vegetable stews, and the sweetmeats, are cooked ; and you exhaust the whole inventory of the mechanism, from the plough downward to the necessaries of domestic furniture, of the agricultural life of the Dakhan ; of which the essential element, and the prime movers, so to say, in the development of the latent wealth of the soil into food and other products for human use, are the hardy, thrifty *rayat* and his wife, and his oxen, and his incomparable plough.

It is the simple agricultural life pourtrayed by Hesiod, Virgil and Pliny, and by the *Scriptores* [Varro, Columella, Taurus Æmilianus, and Cato] *Rei Rusticæ Veteres Latini*, and by Tusser; but without the restless, hustling spirit of emulous competition, that, from the first days of their enforced exodus from the East, has been the necessarily disturbing and disintegrating element in the agricultural, as in the general progressive civilisation, of the Aryas of the West. It is not meant that the steam-farming of England and America, if applied in India, would not augment the productiveness of its soil, or at least extend its area of production ; although for all the social disadvantages resulting from the growth of large estates in the West, the only advantage, in this very respect of extended arable land, England has over India is that, while a fraction less than one-third of the surface of land and water is under cultivation in India, in England one-half of the total acreage of the country is cultivated. But the point of my defence is that the Hindus, having never forgotten their natural interdependence among themselves, and having recognised their indissoluble fraternity as the first law of their social organisation, the responsibilities and obligations of which are enforced on all, from the highest to the lowest, it would be impossible to introduce prematurely the vaunted farming of England into India, even if its methods and appliances were in themselves improvements, without involving the destruction of the beneficent co-operative rural life whereon the whole system of the civilisation of the Hindus has been immemorially based. That system, and that life, like all else that is of human origin, are probably destined to disappear ; but, if we are wise, this will happen gradually, through self-evolved changes in the internal consciousness of the race of Brahmanical Hindus ; and as answerable, in the present, for the happiness of the people of India, as distinguished from the "progress and prosperity" of their country, or, in other words, its scientific exploitation, the last thing to be desired or encouraged by us in the hastening forward of the probably inevitable reconstruction of Hindu society by means for which the people of India are not yet prepared, and which could therefore only act with destructive and revolutionary effect.

The introduction of the machinery of Western agriculture into India is quite impossible in the present economic condition of the country ; and every attempt at it in my experience, has proved a flagrant and ridiculous failure. I remember a steam-plough being brought out to one of the Native States in the Bombay Presidency. It was led out festooned with roses and jasmine, like an Indian bridegroom, into a rich *regur* field, and all of us who were called together to witness the prodigies it was to perform, were also wreathed with roses, and touched on our hands and foreheads with *atar*, and sprinkled all over with rose water; and then with a snort, and a shriek, and a puff of smoky steam, the gigantic mechanism made a vigorous, loud-hissing rush forward, but, as was at once perceived, also gradually downward, until, after vainly struggling for awhile against an ignominious fate, it at last settled down silently and fairly foundered in the furrow it had so deeply delved into the soft, yielding soil. And then not all the king's soldiers, and all the king's men, nor all the servants of the incensed Bhavani [Athene Boarmia, the "Ox-yoker" here] the hereditary blacksmiths and carpenters from the neighbouring palatine village, could do anything with the portentous mechanism. Nothing could be done with it as a steam plough. It had been recklessly brought into a sacro-economic system wherein it had no place, except as another god, and another god it was at once made. As soon as it could be moved out of the field it was sided into the village temple hard by; and there its huge steel share was set up on end, and bedaubed red, and worshipped as a *lingam*, or symbol of Siva ; and there, I suppose, it stands an object of worship to this day.*

The Indian plough is, in short, part and parcel of a fixed crystallised life, wherein it is

* The late Mr. Grattan Geary, Editor of *The Bombay Gazette*, on reading this article in 1888, at once sent an agent to Jamkandi, who found the plough-share then still there in undisputed deity, as evidenced by its daily daubs of dominical red.

the primitive and primary integrant molecule, regulating the relations, and determining the dimensions, and the ultimate character of the entire and indissoluble economic, social, and religious system built up on it. In that life all are but co-ordinate parts of one undivided and indivisible whole, in which the provision and respect due to every individual are enforced under the highest religious sanctions, and every office and calling perpetuated from father to son by those cardinal obligations of caste on which the whole heirarchy of Hinduism hinges.

Thus the social aspects of a Dakhan village are as of a large family, all living together that united life of contentment in moderation, which is the perfection of human felicity. The first sound heard in one of these villages after the deep stillness of the night and just before the dawn, is of "the house father," who having, on rising, worshipped the family gods, is now moving about quietly, with his head and shoulders still wrapped in the *chadar* [" sheet "] in which he has been sleeping, quietly, arousing the bullocks and oxen, stalled either in a yard behind the house or in the porch in front.* It is a devoutly soothing sound, for it tells you at once that you are among a people setting about their daily duties *actually hand in hand with* GOD.

Then having got the cattle out into the road, and lit his cigarette of tobacco rolled in a leaf of the *apta* [Bauhinia tomentosa], and taken up his breakfast of *jawari* or *bajri* cakes, cooked the day before, and tied up in a cloth over-night, by his wife, with an onion, or some pickle, he strolls off at daybreak, keeping his oxen before him, to his fields; and there yoking the oxen, and stripping to his work, whether it be to plough, and to sow, or to reap,† he works on for a steady hour until eight o'clock; and again, after ten or twenty minutes spent in eating his breakfast, for four hard fagging hours more until mid-day.

Ere yet he leaves his home, the voice of his wife is heard singing as she grinds out from the hand-mill the supply of flour for the day; and this done, and the rooms all swept out and fresh cow-dunged, and the *tulsi* plant before the porch perambulated, and her own breakfast eaten, she cooks the dinner, consisting of fresh baked cakes of *bajri* or *jawari* meal, and either a mess of pulse porridge, or a pot of highly spiced pulse soup, she must be careful to carry to her husband by twelve o'clock. The cultivators within hail of each other generally take this meal together; and after the four hours from breakfast spent in the furrows, or amongst the stubble, they devour it with obvious zest of appetite, joking and laughing heartily all the time: so true is it of the peasant proprietor's independent life all the world over:—

*" Pingue solum lassat, sed juvat ipse labor."

Thus from half-an-hour to an hour is spent; and then up to two or half-past two o'clock, the men lie down to sleep, lying where they had eaten, on their *cumblis*, or out-of-door woollen wrappers. While they sleep, the women dine off the scraps that are left, and then either, at once return to their houses to attend to whatever may be wanted to be done there, and to prepare the supper, or spend an hour or two assisting their husbands in the fields previously to going home.

When the men awake they re-yoke the oxen, and resume their work for three hours more, or until the sun sets, at which signal they return in long winding lanes towards their respective villages, walking along leisurely, chatting and laughing, and always keeping their oxen before them. Then, tying up the cattle, and, after bathing, again worshipping the household gods, the husband at eight o'clock has his supper of pulse porridge.

After this the social life within the village —a life lived here, and now, and in every homeliest detail, with God and Immortality—suddenly bursts into its brightest, happiest activity. The temples of the gods are in turn all visited: those of Mahadeo, "the Great God," meaning Siva, and Bhairava, an incarnation of Siva, and of Hanuman, and any other of the lesser gods to whom there may be temples, or

* The ritualism to be observed in attending to cattle, and especially on the cow, is most minute, and would be exacting, but that it has become instinctive in the race of Brahmanical Hindus. You must not step over the rope to which a calf is tied; and must always approach and pass a cow on your right-hand; and keep your right-arm covered the whole time you are in the cow-shippen; you must never ride a cow, nor interrupt her while suckling her calf, nor be in any way annoysome to her. Shortly after the railway between Poona and Bombay was first opened, a cow having to be sent by a Hindu in the former city to another in the latter, its entrainment for the journey was telegraphed by the sender to the receiver in the equivalent of these terms:—" Her Holiness just booked by the — a.m. train to Byculla [a suburb of Bombay], please be at the station at — p.m. to receive Her Holiness."

† Compare "nudus ara, sere nudus" of Virgil's "Georgics," I. 299; and Hesiod's " Works and Days, 390."

* Compare:—" Robustus fossor rege est felicior." Also the culminating precept of Hesiod's "points of good husbandry."—" The hard working cultivator is beloved alike by mortal man and the immortal gods." " Works and Days," 309-10.

shrines, or altars, or but upraised, ruddled stones,—and these are everywhere.

Hanuman, or "Long-Jaw," is the favourite village god. Originally he was possibly the *totem* of the Vindhyan races of Central and Southern India; and he is adopted as their representative in the Ramayana. But in the officinal pantheon of the Brahmans he is a sort of satyr leader of the oreads and dryads of the wooded mountains and hills and dales of the Malabar coast and Gondwana: and as Arcadian Pan was the son of Hermes, so Hanuman is the son of Pavana, "the Vagrant," "Vagabond" wind, or a personification of Vayu,* who is "the Wind" also. He represents the sun as it seems, to those who pass through the forests of the Sahyadris, to leap from tree to ree above them. The gleams of light that shine suddenly on the wayfarer's path through dark woods, and the pleasurable earth-born glow that springs up in the youthful heart at the sight of the luxuriance of Nature, and again the feeling of awe that at times seizes the lonely traveller on suddenly coming on some uncanny spot, all these are Hanuman. Again, he is the shadows that steal at sunset through forests and across valleys, and from one hill-top to another. The vocal cloud of dust that swept from Eleusis towards the Grecian fleet at Salamis, like a wafted echo of the songs of the Mysteries, the Hindus would probably interpret as a higher apparition of Hanuman. He is, indeed, the topical personification of the vital power of Nature in its more familiar and more playful manifestations and emotions; and these the Hindus as naturally represent by a monkey, as the Semites of Anterior Asia represented them by the wild goat, the *atadu* of the Assyrian inscriptions, and *atud* of the Hebrews; names from which, through their Greek form, we derive the word satyr. Thus, in Western, Southern, and Central India, Hanuman is everywhere the favourite local divinity of the lower agricultural classes, whose innocent gaiety of heart, so promptly responsive to all the pleasanter conditions of their life, he precisely personifies: and in the Dakhan villages the vicinity of his temples is always of an evening a popular rendezvous.

Every month, moreover, and indeed almost every week, some religious anniversary is celebrated; the principal among the agricultural communities of the Dakhan being the following five: The Holi, or Saturnalia of the spring equinox, held towards the end of March. The Dasara, or "Tenth," held early in October, when, after nine days of mourning for the ravages of Mahesh-asura—"the Buffalo-headed demon," from whom the State and city of Mysore take their name—on the tenth day, in joy for his destruction, by Bhavani, all the villagers, the higher and lower "twelve" hereditary village officials, the Brahmans, the whole body of the cultivators, and even the occasional Mahommedan "sacrificer" or butcher within their gates, proceed in their gayest costumes to perambulate the village boundaries, and to worship the trees planted there, more especially the *apta* [Bauhinia tomentosa], and, where it grows, also the *palas* [Butea frondosa]. On this day also the Mahrattas of the great historic families celebrate the declaration of "The Great War in Bharata," the "epos" of the Mahabharata, between the Pandavas and their paternal cousins the Pauravas. Heralded by the arousing, archaic sounds of shawms, and bagpipes and kettle-drums—the last often mounted on a camel,—they sally forth from their palaces into the westward wild ["jungle"] in long, leisurely advancing cavalcades, their horses in full caparison of war, but festooned over their trappings with flowers; and themselves garlanded and crowned with flowers; and their spears, of many coloured fluttering pennons, all hung with flowers; and, as they move along, gathering from every *pulas* tree they pass its yellow blossoms, on turning, at the gloaming, homeward, they joyfully heap them on every woodland altar, or ruddled stone, by the way-side, calling them "gold" [*sona*],—as much as to say: "It would be gold—if we had it—we would heap on you with the like largess of heart." And wherever these gallant Mahratta princes ride that day, in their estatic vision, the good Lord Sivaji rides on before. The Devali, or "Feast of Lanterns" [literally "Lamprows"], held twenty days after the Dasara, and celebrated amid the greatest rejoicings in honour of Lakshmi, the wife of Vishnu, as the goddess of "Good Luck," and of Saravati, the consort of Brahma, and goddess of learning, and protectress of bank-books, ledgers, and all money accounts. These three solemnities are commemorated by all classes of the community.

The two remaining festivals are kept up

* Ariel is possibly, and aerial certainly, a form of Vayu; and both Vayu and [Pa]-vana are radically related; our English words wind, winnow, winter, &c., being more closely cognate with the former; and vague, vagrant, voyage, tan ["vannus," *éventaille*], way, wain, waggon, &c., with the latter.

exclusively by the women, namely, the Nag Panchami, on the 25th of July, in honour of the destruction of the serpent Kali by Krishna; and the Gauri, on the 25th of August, in honour of Parvati in her epithet of Gauri, "the Yellow-Haired." The latter is specially observed by making up sweetmeats in the shape of round balls and eating a couple of them before going to bed. For two months beforehand songs in honour of Gauri are nightly rehearsed by the women. Their principal employment, however, of an evening is in visiting from house to house, arranging the marriages in the village, and settling the names of the latest-born babies. Every Mahratta family has its crest, and no marriages can take place between families having the same crest—a clear survival of totemism.

The Mahratta women of the *rayat* class, although they soon lose the good looks of their girlhood, are a fine, healthy race, tall and straight grown, modest, frank, and chatty; and in their yellow, or shot red and purple, bodices [*choli*], and dark green, or indigo-blue, robes [*sari*], are everywhere, in the fields, or in the village streets, welcome objects to the artistic eye. The ladies of the higher castes, and particularly the *deshast* Brahmanis, are very comely, although not so fair as their *Konkanast* sisters. They are all known at a glance by their great beauty and richer clothing; and as one of them sweeps past [ἑλκεσίπεπλος] in her flowing *sari* of crimson, gold-bordered, nothing can be nobler than its glow against her olive flesh-tints, as it waves round her stately figure, and ripples in gold about her dainty feet, a study worthy of a Lombard master's canvas. And πυγοστόλος also is there, loitering in the shadows of the big temple, not illicit, degraded, and depraved, but a recognised institution, established, endowed, and, indeed, sacramental.

A great deal of conversation also goes on every evening with the village astrologer especially as to the right day and hour for sowing the different kinds of crops; and it is quite surprising to find the full and accurate knowledge the humblest husbandmen show, in these consultations, of the exact time the sun enters the successive signs of the zodiac, by which the sowing of rice, wheat, barley, *bajri*, *jawari*, and every other sort of grain, pulse, and oil seed, *et cetera*, is scrupulously regulated.* They prove themselves indeed as much at home around and about the zodiac, and among the burning stars, as in their own beloved fields, and with their conversable cows and calves and ploughing oxen; and the picturesque, Propertian* epigram:—

Nauta de stellis, de bobus arator.

is foiled of its antithesis in any reference to them.

All this intercourse conducted on the most familiar terms between the members of the same township. and in the open streets, by the light of the flaring oil lamps set, or hung, in every portico, and of the pillar of lamps, when occasionally lighted, before one or other of the temples, is of the most unaffected and cheering sociability:—

"—— that after, no repenting draws."

By ten o'clock nearly everybody has gone to bed; except that when the songs of Tukaram, or the stories from the Ramayana and Maha-bharata are sung on moonlight evenings, these joyous, blameless *al fresco* reunions may be kept up to nearly midnight. Then the deepest night again closes on each village, and its dependent hamlets, until six o'clock the next morning.

Thus in the division of the twenty-four hours the Dakhan *rayat* has, for the past 3,000 years, realised the vainly-hoped-for ideal of the English artisan, and at a twelfth of the cost:

"Eight hours to work,
Eight hours to play,
Eight hours to sleep,
And eight pennies [not shillings] a day."

He has realised also, and in its fullest security, the ideal co-operative life of the day-dreams of the socialists of the West. And is not this co-operative agricultural life of the people of India high farming in its noblest sense and conception of the term?

Pliny, writing on the "Maxims of Ancient Agriculture" (bk. xviii. ch. 8), asks: "In what way, then, can land be most profitably cultivated?" and answers: "Why, in the words of our agricultural oracles, 'by making good out of bad.'" Adding, "But here it is only right that we should say a word in justification of our forefathers, who, in their precepts on this subject, had nothing else in view but the benefit of mankind, for when they used the term 'bad' here, they only mean to say that which cost the smallest amount of money. The principal object with them was, in all cases, to cut down expenses to the lowest possible

* In *The Madras Mail*, 9th July, 1908, will be found a most informing and most interesting article, signed C. H. R., on the Ritualism in Agriculture as observed by the Hindus of Southern India.

* "Navita de ventis, de tauris narrat arator;
Enumerat miles vulnera, pastor oves."
—Propertius ii., 1, 43-4.

sum." And further on, he quotes, "that maxim of Cato, as profitable as it is humane: 'Always act [in farming] in such a way as to secure the love of your neighbours.'"

The enactments embodied in the Code of Manu, and cognate law books of the Hindus, have achieved this consummation for India, from before the foundations of Athens and Rome; and, through all that dark, backward, and abysm of time, we trace there the bright outlines of a self-contained, self-dependent, symmetrical, and perfectly harmonious industrial economy, deeply rooted in the popular conviction of its sacro-sanct character, and protected, through every political and commercial vicissitude, by the absolute power and marvellous wisdom and tact of the Brahmanical priesthood; an ideal social order, we should have held impossible of realisation, but that it still continues to exist, and to afford us, in the yet living results of its daily operation in India, a proof of the superiority, in so many unsuspected ways, of the hieratic civilisation of antiquity, over the secular, joyless, inane, and self-destructive, modern civilisation of the West: and of a truth, it is in the contemplation of the practical workings of this socialistic system of the Code of Manu that the sympathetic Englishman in India drinks deepest of the bliss of knowing others blest.

L'Envoi.

And this is the "unhappy India" of the writers on that country, who know not the things that really belong to its peace, and have acquired all their knowledge of it from "Statistical Abstracts" and "Blue Books."

Unhappy India, indeed! I might rather bemourn the unhappiness of England; where faith for nearly four centuries has had no fixed centre of authority; where political factions rage so furiously that men seem to have lost all sense of personal dignity and public shame, confusing right with wrong, and wrong with right, and excusing the vilest treasons against the Commonwealth on the plea of party necessity; where every national interest is sacrificed to the shibboleth of unrestricted international competition; and where, as a consequence, agriculture, the only sure foundation of society, languishes; and the peaceful plough, the mainspring of industrial activity, no longer holds its proper place of public honour and pre-eminence:—and no longer is heard throughout our land, from far across the fresh fluted furrows, the lulling lilts of the lowly ploughman, who, as he sturdily plods along:—

> "Sweetens his labour with some rural song."

The truth is, that closet publicists and politicians, trained in the competitive economic principles of the West, do not sufficiently distinguish between the prosperity of a country and the felicity of its inhabitants. Indeed, they do not discern the distinction. They dwell with their books, and not among the people; and that men do not live by bread alone is one of the strongest facts of life in India absolutely hidden from their eyes.

What we call prosperity exists only in figures, and has no place in the personal experience of the vast masses making up the population of the so-called "progressive" nations of the West. It merely means the accumulation of amazing wealth in the hands of a few, by the devouring, wolfish spoliation of the many; and in its last result, the bitter, stark, and cruel contrast presented between the West End of London and the East. And do Europe and America desire to reduce all Asia to an East End?

Happy India! where all men may still possess themselves in natural sufficiency and contentment, and freely find their highest joys in the spiritual beliefs, or, let it be, illusions, that have transformed their trade-union organisation into a veritable "Civitas Dei." *

* Mr. Malabari, the sanest and most sympathetic of native Indian [Parsi] "reformers," devoted the whole prime of his life to the advocacy of a rehabilitation of the Panchayat System [*i.e.*, Council of, nominally, 5, *panch*:—compare "punch" the Anglo-Indian "brose" or brew of 5 ingredients—spirit, limejuice, sugar, spice, and water;—and the Greek "punch," πενταπλόα,—the words *panch*, πέντε or πέντα, and five, being all one word, originally meaning "outspread"—like the hand with its 5 fingers] in Indian villages; but it has all been in vain—so far. It is a proverbial saying in India:—"In the Panchayat is God!" We speak of "the Wisdom of Parliament;" but that is sarcastic-wise, and with reference to the "Parliament of Dunces," the "Addled Parliament," the "Mad Parliament," &c. Nothing could be more fair, and reasonable, and beneficent, than our regulations for raising the land revenue in India, and it compares favourably with the rule of the Mahrattas and other Hindu princes, who levied from their Muslim subjects,—including the Nizam of Hyderabad, and the Emperor of Delhi, one-fourth of the assessed value of their crops,—the *chauthai*, or "chout" of which one reads so much in English works on India of late in the eighteenth and early in the nineteenth centuries. But even the *chauthai* was not so onerous as is often represented; for in closely parallel circumstances the Spartans took one-half of their crop values from the Helots, and the Athenian Eupatridæ one-sixth from the Attic Thetes. They all gained from the assessments being fixed—at least when there were no droughts!

* "Where everyone has his divinely co-ordinated place, and his security, and honour, and content therein; and no one is envious of another's higher estate, and reverence and happi-

Happy India, indeed! But how long before the Saturnian reign shall be brought to the same end in India as it was in Europe four centuries ago? The sight of our manufacturing and commercial wealth, the fruit of our competitive civilisation, so deceptively beautiful without, but within full of gall and ashes, like the apples of Sodom, has inflamed the people of India, in the neighbourhood of Calcutta and Bombay, with the same insatiable greed of gold as the opulence of Rome excited in the barbarians who were provoked by it—"the Nieblung's gold"—to the destruction of the Empire; and wherewith again the ancient and mediæval fables of "the Riches of the the East" inflamed the avarice, in the fifteenth and sixteenth centuries, of the renascent nations of the West, and lured them on, in speculative quest of India, to the huge invention of the Americas.

Through this contact between the East and the West at the Presidency towns, the traditionary ideal of life among the Parsis and Hindus is gradually becoming superseded by the English ideal; according to which the basis of all social advancement, and the standard of all moral worth, is the possession of money. That hangs on the hazard of a crude competition, in the prizes of which but few, of the many called, are chosen to participate; and thus in the place of the old world content with the conditions of existence, we are arousing in India a universal spirit of discontent, the characteristic incentive of modern civilisation, and have needlessly exaggerated it through the malign influences of the fastidiously secular system of eleemosynary education enforced by us on the country. The sinister shadow, as of the legendary Upas tree, on Western civilisation, is the slow poisoning wherever it becomes rooted, of the vital atmosphere of the spiritual life latent in our human nature; and there was no necessity for anticipating, by a direct attack on the ancestral faiths of the people of India, led as it is by professedly Christian missionaries,* the inevitable catastrophe that has everywhere dogged the steps of exclusively material civilisations, and at last involved them in self-destruction.

Examining in 1863 or 1864 some Parsi boys in the Fort School in Bombay, on my asking the meaning of the word "happiness," one of them instantly stretching out his arm toward me replied energetically, and with the applause of all his little class fellows:—"To make a crore of rupees [£1,000,000] in cotton speculations, and drive into (*sic*) a carriage and four,"† —adding, however, in the yet uncorrupted spirit of the boundless philanthropy of the ancient Buddhism of Asia—"and to give away lackhs upon lackhs in charity:"—and as well in princely public benefaction, as in inexhaustible private done and dole. Only a few weeks [now 21 years] ago a distinguished Bengali Brahman, to whom I was pointing out that he was not in the least obliged to break formally with the religion of his forefathers because he was an "Agnostic," replied:—"You do not understand. It is not simply your education that has made me an Agnostic; I have rather been forced to become one by the high standard of civilised life you have set up in India. I really cannot afford to be a Hindu, and spend so much as a good Hindu must on his 'undivided family,' and in general charity; not if I am to keep up appearances, on the same income as Christian and Muslim gentlemen, who have no such compulsory demands on their means."

Thus the lesson of the Indian plough, if rightly read, goes deep; and he who runs may read it‡; and the deepest gulf before England is that we are ourselves digging, by forcing the insular institutions of this country on the foreign soil of India,—India of the Hindus. That is the special lesson of the English steam-plough laid up, in divinity, in the Jamkhandi State.

POST SCRIPTUM. Sept. 19th, 1909.—I must add a postscript to thank Sir James Monteath for drawing attention to my negligence in not referring to the fruitful work done by the late Sir James Campbell in connection with the excavation of the Buddhistic relic mound at Sopara; and to thank him also for dealing

ness therein; where God is sought, and found, and magnified in everything; and where every one seeking and ensuing every other's good, realises for all the perennially inspiring human vision of a New Heaven and a New Earth."—St. Augustine, De C.D. xxii. 20, 30 *précis*-ed. Long may "God stay them in that felicity" in India. No wanhope—notwithstanding present appearances there! "Sinister omens" are, after all, sent from the right hand of the gods; and thanks to the wary wisdom, and deft dexterity of the Brahmans as "men of affairs," the concession of representative government, of the English type, to India, may yet serve to revivify and reinvigorate, and definitively restore their pristine powers, and salutary, because natural supremacy, throughout the country.

* The first and best triumphs of Christianity were won by absorbing and transmuting the classical paganism of Greece and Rome, and not by arrogantly defaming it. The true destiny of Christianity in India is not to reprehend and destroy, but to amend and regenerate Hinduism.

† "Quadrigis petimus bene vivere."—Horace, *Ep.* i. 11, 29.

‡ And verily, "he may run who readeth it."

so considerately with my default, when he might well have come down on it with the full weight and edge of an avenging "Lochaber axe." In a private letter Sir James Monteath states that there is no sheer drop of 2,500 feet at "Lodwick Point," Mahaleshwen, into the Southern Konkan. I saw the horse leap from the point, silhouetted against the sky as picturesquely, and impressively, as the camel on the monument to Gordon at Khartoum; and immediately afterwards looked down on it flattened out in the plain below; and the figure of the depth of the fall I erroneously give, is that, I presume, of the height of "Lodwick Point" above the general level of the Southern Konkan, and certainly not above the very spot on which it actually lay dead. Both these errors, the one of omission, and the other of commission, shall be corrected in any permanent reproduction of this paper, with others in praise of India, I may yet publish before I cease altogether to live to the purposes of my foster "motherland."

The only "toad-in-a-hole" of which I can speak with authority, is the lusty De'nshire "prog" of a chunk of beef baked in a large "cloam" dish with batter. GEO. B.

LONDON TRADE SCHOOLS.*

The problem of problems in London and elsewhere is to prevent children of fourteen years of age drifting into unskilled labour in which there is no element of permanence. The difficulty is increased by the decay and gradual disappearance of the apprenticeship system and the altered conditions of employment in workshops, which make them unsuitable places for the training of craftsmen.

An elaborate scheme of junior intermediate and senior scholarships established by the London County Council makes ample provision for the brilliant children of the London Elementary Schools. The really capable child, even of the poorest parents, may reach the highest position by means of the scholarship ladder, passing at the age of eleven years into the secondary school, and thence by means of scholarships at the age of nineteen to the University or higher technical school. Provision is also made for the transference of children who do not reach scholarship standard to pass on to a higher form of elementary school in which a special bias may be given in training for commercial or industrial life in a course of instruction extending for a year or two beyond the age of compulsory attendance.

The Trade School, however, is of a very special type for children who have to enter upon their life's work at the age of sixteen or seventeen, and who have already decided upon the trade they wish to enter. The age of entry into the trade school coincides approximately with that at which the boy or girl normally leaves the elementary school, viz., thirteen or fourteen years of age, and the course of instruction lasts for two or three years.

In London the boy or girl of fourteen who is physically strong and has received a fairly good education, has no difficulty whatever in obtaining employment at a rate of remuneration which appears liberal for a child of this age. The consequence is that in the elementary school the vast majority of the children leave immediately they reach the age of fourteen and become wage-earners. In order to keep children at school above the compulsory age for any definite period it is absolutely necessary, not only to give them free education, but, in addition, maintenance scholarships which will recoup the parents to a certain extent for the loss of the earnings of the children.

The scholarships for trade schools for boys extending over a period of three years are generally of the value of £6 for the first, £10 for the second, and £15 for the third year. The trade schools for girls generally have a two years' course, and the value of the scholarships is £8 for the first and £12 for the second year. Unsuccessful candidates who do not obtain scholarships may be awarded free places. For other pupils a low fee of generally 10s. a term is charged.

No candidate is eligible for a scholarship whose parents or guardians have an income which exceeds £160 a year from all sources.

The special features of the London Trade Schools are:—

(1) The assistance given in the direction of the trade teaching by consultative committees of business men and women engaged in the particular trades for the training in which the school provides.

(2) The appointment of After-Care Committees, the members of which interest themselves in the scholars and advise them with regard to employment at the conclusion of the school course, and afterwards see that the conditions of their employment are satisfactory.

(3) The continuance of the general education of the pupils, only about one-half to two-thirds of the school time being given to actual workshop instruction.

(4) The prominence given to art instruction, not only in the technical requirements for the particular trade, but for the general development of a high standard of taste.

(5) The employment of teachers who have attained distinction as practical workers, and who approximate the instruction asfar as possible to workshop conditions.

(6) The holding of exhibitions of students' work to which employers are invited and at which offers are frequently made for the employment of students.

Trade schools for boys have been established in engineering, silversmithing, bookbinding, furniture and cabinet making, carriage building, art woodcarving, and various branches of the building trades. The trades for which schools have been established for girls are trade dressmaking, laundry work, upholstery, ladies' tailoring, waistcoat making, corset making, millinery, designing and making of readymade clothing, and photography.

* Abstract of a paper read by Dr. C. W. Kimmins before the Educational Section of the British Association at Winnipeg, 1909.

The development of trade schools in London is proceeding rapidly. The competition for the scholarships is becoming keener every year, and the work of the students is finding increasing favour with employers. No difficulty is experienced in finding suitable employment for boys and girls who have passed through the schools successfully.

TRIPOLI OSTRICH FEATHERS.

The trade in ostrich feathers is an important item in the commerce of Tripoli, in Barbary. The feathers are brought overland, from Central Africa, by caravans, and are then exported to Paris and London. One of the largest dealers in Tripoli estimates the value of the annual average imports from the interior at £20,000. The exports to Paris and London in 1905, 1906, and 1907 were valued respectively at £12,000, £11,000, and £10,000. The usual kinds of ostrich feathers known to the trade come into the Tripoli market. These are whites, blacks, feminas, byocks, spadonas, boos, drabs and floss. The Arab dealers bring them in unsorted packages, containing feathers in various qualities of each kind, and it therefore requires expert knowledge to buy advantageously from the natives. The goods are sold in Tripoli by the "rotl" (the Tripoli "rotl" is about eighteen ounces). The feathers are washed and sorted, but are not dyed or curled. They are washed in soapy water, and when still wet, are beaten. A handful of them is taken by the stems, and slapped against the floor with a force that, to the uninitiated, would seem to be enough to break them to pieces. This is done, according to the American Consul at Tripoli, to bring out the flues or barbules, the miniature feathers extending from the barbs, and to give the plumes a fluffier, richer appearance. A good ostrich plume will have two or three layers of feathers, its tip should be perfect, and it should have no transverse cuts along the vane. For the retail trade, two plumes are usually mounted together. A large quantity of Tripoli feathers come from ostrich farms in the Kanu district. The finest feathers which bring by far the best prices come from the Wadai and Darfur districts, and are taken from wild birds. The prices in Tripoli are to a certain extent influenced by the London and Paris markets. The contents of the original packages differ largely in kinds and qualities, and as the feathers are bought by the package, the prices, of course, vary largely. Some idea of the Tripoli prices may be obtained from the following quotations:—Whites and blacks (parcel containing twenty per cent. whites and eighty per cent. blacks) four shillings and eightpence per "rotl" of eighteen ounces; drabs (parcel containing seventy-five per cent. drabs, the balance being feminas, spadonas, byocks, &c.), two shillings and fourpence per "rotl" of eighteen ounces. The caravans usually begin to come in from Central Africa during the month of April and June. July and August are the best months for the trade.

ARTS AND CRAFTS.

The Arts and Crafts Exhibition Society.—The announcement that the Arts and Crafts Exhibition Society will hold its ninth exhibition in London early in January and will return to its old quarters at the New Gallery, will be good news to artists' craftsmen and craftswomen who have something to exhibit which aims higher than the greater part of the work to be seen at the small shows held under other auspices throughout the year. To those interested in the modern craft movement, it is interesting in more ways than one. It recalls the fact that only twenty-one years ago the expression "arts and crafts" was practically unknown and conveyed absolutely no meaning to the man or woman in the street—who, when it first opened, had no idea at all what to expect from an exhibition so strangely labelled. It is further somewhat of an object-lesson in the changes which come imperceptibly in the meaning of words. Arts and crafts to the founders of the Society did not mean by any means what the words naturally bring to our minds to-day. Indeed, the men who promoted the first exhibition were not, with a few exceptions like William Morris, Mr. de Morgan, and Mr. Cobden-Sanderson, craftworkers in the modern sense of the term. And, though a certain amount of embroidery (mainly by the wives, daughters or friends of members of the committee) was to be seen on the walls, the bulk of the exhibits consisted of work executed by well-known firms of paperstainers, glassworkers, metalworkers, or whatever they might be; work, in short, which differed from the ordinary ruck of trade production because it was designed by competent artists and executed by good workmen trying to do their best, but not in being the output of an artist turned craftsman for the nonce, or of handicraftsmen working and exhibiting on their own account. It was insisted upon at these early exhibitions that the name of the designer of the objects shown should be given—a rule which made some firms refuse to exhibit—but it was rather the exception to find the name of the executant mentioned at all. This may have been, and probably was, due in part to the prevalence of a somewhat different standpoint among the members of the committee from that of to-day; but the mere fact of the change which has come over the point of view is proof of how much the Arts and Crafts Exhibition Society has done since its formation to further the cause of art and handicraft in this country.

Before the Society's first exhibition the "artist-craftsman" was almost an unknown species—to-day he is to be found in every street. It is true, of course, that William Morris had been at work for years before the first Arts and Crafts Exhibition, that there was at least one guild of craftsmen in London, and that pioneers like Mr. Cobden-Sanderson were already working at an artistic trade; but it was the opportunity for designers and skilled workmen to show their work under their own names, to get to know each other and see what other folks similarly

engaged were doing, together with the opening of the eyes of the public which resulted from such an exhibition, which really made it possible for the artist-craftsman as we know him to-day to exist at all. If some old-fashioned workmen think that we got along quite as well, if not better, without him, they must remember that he is after all of very recent creation and must be given time to find not only his level, but his own feet.

Women and the Artistic Crafts.—In view of the numberless women practising various artistic crafts to-day, it is rather curious to note that no woman's name appears in the list of the first promoters of the Arts and Crafts Exhibition Society, and that, though there were quite a number of women exhibitors at the first exhibition, the overwhelming majority of them showed only embroidery or needlework of some kind. Indeed, no woman's name occurs amongst the members of the committee until 1903, though as early as 1889 there were three women members of the Society —Mrs. de Morgan, Miss Faulkner, and Miss May Morris. Facts like this help us to realise how really new are the woman bookbinder, the woman jeweller and silversmith, and others whom to-day we take as a matter of course. There have doubtless been women craft workers of various kinds from very early times. In the days when craftsmen worked at home no doubt the female members of the family were often employed in the work in different capacities as a matter of course; but the craftswoman of the present day is really a product of the twentieth century and of the very last years of the nineteenth. She is generally part artist, part workwoman, and part, it must be admitted, shopwoman. She designs her own work, makes it herself with the aid, perhaps, of a few pupils and apprentices, and sells it herself—either at her own "studio" or through exhibitions and other agencies.

It is in the capacity of tradeswoman that she has at times brought discredit on her calling, and rather justified the kind of sneer with which some people are wont to talk of "women's work." Naturally, craftsmen and women, like other folks, produce to sell, and some of them (many of them, in fact, both men and women) would find themselves in a very tight place if they did not dispose of their wares. There are women craft-workers who have always rated their work at its full value, and let would-be purchasers take it or leave it as they liked. But, still, it is, in the main, in their methods of selling their work that women have so largely failed. Of course, except in embroidery, a woman is heavily handicapped. She cannot, as a rule, get taken on in, say, a bookbinder's, a jeweller's, or a silversmith's workshop—and so, whether she has capital or not, she is practically forced to set up a studio of her own, and get along as best she can by giving lessons and working on her own account. Still, the fact remains—and it is to be deplored—that the ordinary woman-worker has been so anxious to dispose of her work, no matter how or where, that she has led many people to look upon woman's work in the artistic crafts as something about on a level with the kind of thing usually associated with bazaars. This is the more to be regretted because there exist many competent craftswomen whose position really suffers from the action of their less competent—or sometimes only less wise—sisters.

The Women's Work Exhibition at Olympia.—The Women's Work Exhibition at Olympia hardly included as much craft work as the posters led one to expect to find there—and though it was in a sense "International," no very large proportion of the exhibits came from regions beyond the British Isles. The show of the Dansk Kunstflidsforening (the Danish Society for Artistic Handicrafts) comprised not only pottery, embroidery, lace, &c., from Denmark proper, but also a collection of work from Greenland, not the least interesting feature of which were the leather belts, &c., ornamented with patterns formed of tiny bits of coloured leather sewn on to them which looked, at first sight, like plaiting or bead work. This is probably a modern and rather less workmanlike version of the sort of woven leatherwork from the same region to be seen in the museums, but it is still very pretty and attractive. Another interesting foreign exhibit was that of the Sicilian Industries, consisting entirely of needlework. The drawn thread work and embroidery for blouses was especially good, and the coloured Welsh flannels and poplins with drawn work ornamentation were not only effective, but very much on the right lines. Drawn work on a coloured ground offers many more opportunities than the plain white work. On one of the stalls were a few specimens of Javanese weaving, amusing in design and very pleasant in colour.

Amongst the exhibits from nearer home, the quasi-celtic designs for embroidery, leatherwork, &c. shown on the stall of the Irish Decorative Art Association, were characteristic if a trifle weird. It seems rather a pity that the people who have had the happy idea of reviving the old Italian paper ornamentation, which we know so well on old reliquaries and the like, have not made better use of it. This kind of work is pretty when it is used for carrying out a really suitable design, but it is not every pattern by a long way which lends itself to execution in tightly rolled coils of paper, and there is no inherent charm in the material to hide the deficiencies of an inappropriate design. Miss F. M. Rimmington's jewellery was tasteful, well made and moderate in price. The Misses Tebbs showed some interesting *punto tagliato* embroidery in colours, and Miss R. M. Jacot some very good cane and Indian baskets. In short there was good work of all kinds—embroidery, weaving, basketmaking, jewellery, and what not, to be found in the exhibition, but it had to be picked out from amongst a good deal which was, to speak frankly, quite trifling. One cannot but feel that better work

would be done if the workers could afford to go on quietly, doing their own work without having to spend their energies on producing the kind of stuff which they think will sell at exhibitions of this kind.

CORRESPONDENCE.

MAHRATTA PLOUGH.

Sir George Birdwood, in his very interesting and learned "Mahratta Plough," the first part of which is given in the Society's *Journal* of the 17th instant, says of Sopara, that "the well-known tope here was recently shown by Messrs. Mulock and Sinclair, of the Bombay Civil Service, to be a Buddhist relic mound." It is, no doubt, true that these gentlemen made a conjecture to that effect, and Mr. Mulock gave help in the excavation. But I think, and I feel sure that Sir George Birdwood will agree with me, that it is due to the memory of the late Sir James Campbell, K.C.I.E., to point out that he, with the aid of Pandit Bhagwanlal, arranged for the excavation, personally supervised it, and thus verified the theory; at least, the main part of the credit for the actual discovery is due to him, whose zeal in matters of antiquarian interest was intense and unbounded. A detailed account of the *stupa* and its contents is given in Vol. XIV. of his *Bombay Gazetteer*.

The following part of the discovery remains to me a mystery, but it may be capable of explanation by some members of the Society expert in biology. There was found a live frog in the position thus described by Sir James Campbell—"inside of the central relic chamber, about eight feet below the stone coffer; that is, under about 22 feet of solid masonry, and with about 35 feet of solid masonry on either side of it." I saw the frog soon after it was brought to Bombay with the relics. It was so attenuated that parts were almost transparent, and the beating of the heart could be seen with the naked eye. It died four days after being removed from the *stupa*.

I understand that there are other cases of frogs being found in circumstances indicating a very long life, but this *stupa* is believed to have been constructed in the second century of the Christian era, and it is hardly credible that any animal could live for 1,700 or 1,800 years. Of course it is possible that the *stupa* may have been opened and re-closed after the original construction, but it is not conceivable that it would be re-closed with an amount of trouble and care which could be due only to reverence except by Buddhists, and although Buddhism apparently lingered in Thana longer than in other parts of India, it was certainly extinct at the beginning of the seventeenth century. The position must therefore have been unaltered at least some hundreds of years. Unless a frog can live for some or many centuries, the problem is how this frog or the germ of it could have got into the position described after such a structure was completed. J. MONTEATH.

Bellair, Charmouth, Dorset,
September 19th, 1909.

[There are numerous stories of toads (and if toads, why not frogs?) having been found embedded in rock, but they all lack verification, and are discredited by biologists. They are generally believed to be accounted for by the animal having fallen into some crevice or cranny, where it has been found.—ED.]

OBITUARY.

LORD TWEEDMOUTH.—Lord Tweedmouth, who died in Dublin on the 15th inst., was a member of the Society of over thirty years standing, though he never took any active share in its management. He was elected in 1876. He was born in 1849, and was at Harrow and Christ Church. He entered Parliament in 1880. In 1892 he became one of the Whips of the Liberal party, and held the office until his succession to the peerage in 1894. When his party came into power in 1905 Lord Tweedmouth became First Lord of the Admiralty. In 1908 he resigned this office, and became Lord President of the Council, but failing health soon compelled him to retire altogether from the public service.

QUESTIONS AND ANSWERS.

QUESTIONS.

"Can any of the members of the Society or readers of this *Journal* inform me through its columns the names of electrical engineering firms in or near London where an efficient training can be had in dynamo and motor construction, shop work, &c."—S. V. SETTI, care of Messrs. Willans and Robinson, Rugby.

[Any replies to this query should be sent direct to Mr. Setti.]

GENERAL NOTES.

THE IRON AND STEEL INSTITUTE.—The Autumn Meeting of the Iron and Steel Institute will be held in London from September 27th to October 1st, 1909. A number of papers will be read and discussed; visits will be paid to various well-known engineering works and other places of technical interest, and in the evenings social entertainments of various kinds will be provided. Further information may be obtained from the Secretary of the Institute, 28, Victoria-street, S.W.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

THE EXAMINATIONS OF 1909.

The Society's examinations have now been carried on on their present system for a little more than fifty years. They were established in 1856. In 1857 the first provincial examination was held, and in 1858 the system was established under which local committees were appointed to supervise examinations worked from a single centre. From that date up to the present the examinations have been held on the same plan, with only such modifications and developments as were rendered necessary by the general progress in education, and the consequent demand for more stringent and more specialised tests. On two occasions, in 1871 and in 1879 it was proposed to discontinue the examinations, and on both the idea was abandoned, in consequence of pressure put upon the Council by local institutions.

From time to time, subjects have been dropped out as they came to be dealt with by other agencies, and new subjects were introduced to meet the demands of Commercial Education. On the whole, however, the original system still remains, and it has certainly stood the test of time remarkably well.*

Up to 1880 the examinations were free, and the Society expended a very large amount of money on their development. When in 1882 the idea of abandoning the examinations was given up, it was determined to try whether they could not be made self-supporting. It was believed that a fee of 2s. 6d. for each candidate would be sufficient at all events to prevent a serious loss. In practice this anticipation proved accurate, and from that date to the present, this fee has been charged.† When it was first determined upon, it was believed that it would serve to minimise the loss, and the Society was quite prepared to expend a certain amount annually on the examinations. But their enormous development during the past five and twenty years has enabled them, since the number of entries became large, to be carried on without loss, and in some years even to bring in a small margin of profit. Of course many departments of the examinations are still unprofitable. But the profit on those subjects for which very large numbers enter is just sufficient to make up for the loss on the non-paying subjects, and so long as the Society is not called upon to provide amounts which would be a serious tax upon its moderate resources, the Council are, of course, perfectly content to carry on a useful public work, without much consideration as to whether the actual result is a small profit or a small loss. That the work itself is useful and is appreciated by the public is made evident by the large numbers which now avail themselves of the examinations.

Previous to 1880, when the examinations were free, the largest number of candidates in any year was a little over 2,000. This number was reached and surpassed in 1890. During the next ten years there was a steady annual increase, till in 1900 there were nearly 9,000. The effect of the Technical Instruction Act of 1889 sent the numbers up in 1901 to over 13,000. In the following year there was a trifling increase. In 1903 they passed 16,000, in 1904 they nearly reached 18,000, and in 1905 they exceeded 21,000. In the next three years there was a moderate increase up to 22,000, and this year they have again shot up to more than 25,000. This growth of the examinations since they were re-organised in 1883 is shown in diagramatic form on page 945.

In last year's Report on the examinations it was stated that no great alterations had been made since the changes in the system which came into effect in 1905, and

* Those who are interested in the history of the Examinations, may refer to an account of their origin and progress given in the *Journal*, April 16th, 1909, vol. lvii., p. 431.

† A lower fee is charged for the Elementary Stage.

that it was not proposed to make any alterations in the Programme for the present year. During the course of the present Session some suggestions were made to the Council that it would be advantageous if the Examinations could be spread over a longer period, since it often happened that candidates were prevented from taking certain subjects because they were set down for the same day as others for which they desired to enter.

As it was evident that this was a question which affected the Local Committees rather than the Central office, the Council in April last addressed a circular to the Secretaries of all the Examination Committees, asking them to ascertain the views of their Committees as to the extension of time, and to report whether they thought if 9 or 10 days were available, instead of 5, it would be an improvement.

There were at that time nearly 400 Centres to whom the circular was addressed. A little more than a half of them replied. Of the replies, about one-fifth were indifferent, rather more than two-fifths were in favour of the proposed alteration, and rather less than two-fifths were opposed to it. The opposition of most of the objectors was based on the difficulty of providing Superintendents for the examinations, and also of making provision for the very large number of examinations which are now held throughout the country, most of them at about the same time. It may be added that of the replies from the more important Centres, a considerable majority were opposed.

The Examinations Committee very carefully considered the replies to the circular, and they ultimately determined to recommend to the Council that the result of the enquiries did not appear to justify any alteration in the existing system. This recommendation was adopted by the Council, and consequently it is not proposed to make any change in the length of the time-table.

In answering the circular, a great many of the Committees suggested that the work of the examinations would be very much facilitated if a single Superintendent could be permitted to supervise the examinations, when only a small number of candidates were present, instead of the existing rule being enforced, which requires at least two.

The Society's Committee therefore added to their recommendation a suggestion that the rule as to Superintendents should be modified, so that where the number of candidates did not exceed ten, a single Superintendent should be considered as sufficient. This suggestion was also approved by the Council, and the alteration has been embodied in the rules for next year's examinations.

The only other change of importance in the regulations refers to the syllabuses for modern languages. Up to last year the rule was that in all modern languages a student should be given a choice of translating passages of a scientific, technical, or commercial character. Last year, in consequence of a number of recommendations from Local Committees, it was determined to modify the syllabuses of the Advanced Stage of modern languages, so as to allow a student possessing a good literary knowledge of a language, without a familiarity with the technical terms of science or industry, to qualify. The change appears to have been appreciated, and was approved both by the students and the examiners. It has therefore been determined to extend it also to the Intermediate Stage. The syllabuses have accordingly been modified in the Programme for 1910.

The Council do not believe that this alteration will in any way lessen the commercial value of the examinations, since they are satisfied, as stated in last year's report, that a student possessing an advanced literary knowledge of a language, would be able to turn that knowledge to account in commercial pursuits, and that he would soon be able to acquire a familiarity with the technical terms required in the special branch of industry or commerce in which he might be engaged.

The examinations this year were held at 414 centres in the week commencing March 29th, and lasted from the Monday until the following Friday. The results were issued at the following dates:—Advanced Stage, June 17th; Intermediate Stage, July 19th; Elementary Stage, August 16th. Having regard to the very large numbers of papers to be dealt with, no prospect can be held out of the results being issued at earlier dates.

The Commercial subjects included, as usual Book-keeping, Accounting and Banking, Shorthand, Typewriting, Economics, Précis-writing, Commercial Law, Commercial History and Geography, Arithmetic, Handwriting, and Modern Languages. The other subject of examination was Music, divided into Rudiments of Music and Harmony.

The Society this year awarded 34 Silver and 43 Bronze Medals, the former in the Advanced Stage, and the latter in the Intermediate. It also gave away money prizes to the value of

£118, besides the prizes, amounting in all to £30, provided annually by the liberality of the Clothworkers' Company.

The total number of candidates at the examinations of 1909 was 25,042 (Advanced, 4,777; Intermediate, 11,076; Elementary, 9,196). This is an increase of 2,535 upon the 22,597 candidates of 1908, the increase being distributed over all three stages (Advanced, 487; Intermediate, 1,038; Elementary, 920). The number of papers worked by these candidates was—Advanced, 5,433; Intermediate (including Theory of Music), 12,512; Elementary, 11,069, or 29,014 papers in all. In addition to this there were 65 Shorthand and Typewriting candidates at the Special Army Examinations. In addition to these, again, there were 656 candidates in Colloquial Modern Languages, and 392 in the Practice of Music. The total number of candidates who were examined in all subjects by the Royal Society of Arts during the year ending July last was, therefore, 26,157. A comparative view of the numbers examined during the last five years (1905-9) is given in Table A (page 940).

The considerable increase above noted (from 22,597 to 25,042 candidates) was spread over practically all the subjects of examination, the only subjects showing a decrease being Italian, Spanish, and Swedish, and even in these the difference was very trifling. Last year there were three candidates in Japanese and one in Hindustani. This year there are none in either subject, but for the first time Chinese appears on the list. It attracted two candidates. As has been the case for some years past, the greatest number of entries was in Book-keeping, which shows a total of 9,402 in all stages—nearly a thousand more than last year. The next largest number is Shorthand, in which there were 7,480 papers worked—an increase of about 600. French comes third. This subject has shown a steady increase of recent years, the numbers being 3,287—an increase of about 500 over last year, and 1,200 over 1905. It is satisfactory to note that this subject is now attracting so large a number of candidates. It is also satisfactory to record a steady advance in Arithmetic. Not many years ago in reporting on the examinations, attention was drawn to the fact that this, among the most important of all subjects, did not receive a due measure of attention. This year there were 2,185 candidates, of whom the largest proportion (1,393) were in the Elementary Stage; last year 1,788 entered. It is still to be desired that more candidates should enter for Arithmetic in the two higher Stages, especially in the Intermediate. Another popular subject is Typewriting. This year there were 2,092 candidates, of whom just half were in Stage I. Last year there were 1,909.

The above are the only subjects attracting such large numbers, though nearly a thousand (precisely 982) entered for Handwriting and Correspondence in the Elementary Stage. For German there were 835 candidates; last year there were 740. This is a good proportionate increase, which shows itself in all the stages. For English there were 423 candidates—349 in Stage II. and 74 in Stage III. This is an increase on the 353 candidates of last year. For Accounting and Banking there were 369; last year there were 288. Commercial History and Geography, taking all three Stages together, produced 370 candidates, last year there were 344. The increase here was in the upper Stages, in the Elementary (which does not include History, there was a decrease). In Economics there were 138, as against 105. Précis-writing 169—last year 152. Commercial Law has only a nominal increase—216 against 214. Spanish, as mentioned above, shows a slight falling off. There were only 240 candidates this year—last year there were 259. In Portuguese the numbers are actually equal—34; and there were in both years 9 candidates for Danish and Norwegian. Thirteen candidates came up for Russian; last year there were 8. Eight entered for Swedish and 13 last year. The two candidates for Chinese both passed in the Intermediate Stage. The numbers of papers worked in all the different subjects of the three Stages are given in detail in Table G (page 943), while Table B (page 941) gives the numbers of papers worked in each subject in the two higher Stages in each year from 1905 to 1909 inclusive.

While the increase in the candidates in Stages III. and II. is very satisfactory, as much can hardly be said of the character of the papers. So far as can be judged by percentages of failure and success, the increase in numbers does not seem to be accompanied by improvement in quality. The percentage of failures in Stage III. in many subjects show a decline from the average, and are generally higher than last year. In Shorthand, the percentage of failures (75 per cent.) is very high indeed, much higher than it ought to be. But it may be taken as fairly certain that the standard has not been raised, and it may be added that a very careful revision of the papers made it quite clear that it would be impossible

without a serious lowering of the standard, to pass any of those who failed. The reason for this is certainly that candidates insist upon entering for a much higher speed than they are capable of taking. If many of those who had entered for the Advanced Stage (140 and 120 words a minute) had been content with the Intermediate Stage (100 and 80 words a minute) they would certainly have passed; and in the same way a proportion of those who failed in the Intermediate Stage (though here the failure percentage was lower) might have taken the easier certificate in the Elementary Stage, and deferred for another year the more difficult one in Stage II. At the same time it may be remarked that the percentage of failures in Shorthand examinations always seems a good deal higher than the usual percentage failure, which as a rule may be expected to be about 33·33. In Arithmetic also there is a distinct falling off from last year, and so there is in Commercial History and Geography. This was noticed by the examiners. On the other hand, though there was a large percentage of failures in Précis-writing, there was improvement in the general character of the papers. In all the modern languages there is progress. There are generally less failures, and the work is better.

And it must be borne in mind that the quality of the papers must not be wholly judged by the percentage of failures and successes. This percentage is lowered by the larger number of inferior papers. The quality of the work of those at the head of their class remains the same. Every year there is sent in, in many at all events of the subjects, a certain proportion of work of a genuinely brilliant character. There are very often a few papers which stand out from the rest by their superiority. To some extent these are marked by the award of medals, but often they could only receive their due credit if they were placed in a class by themselves.

With regard to Stage II., the percentages of failure in all subjects do not differ very widely from the usual average of recent years, though they are higher than last year. The proportion of First-classes is distinctly low, and, on the whole, the work was hardly up to the standard of recent years. In English there was improvement. In Book-keeping the character of the papers showed a falling off, and there was too large a percentage of failures. In Typewriting the standard was not maintained. The same may be said of modern languages generally; in German the papers were, on the whole, worse than they have been for some years. In the whole of Stage II. it may be said that the work was below the average, and much below the standard of last year, when the papers altogether reached a fairly high level.

Table C (page 942) and Table D (page 942) show the percentages of failures and successes for all subjects in the two upper stages for the present year. The number of entries in some of the smaller subjects is insufficient for such calculations to have much value, but the percentages are given for the sake of completeness.

Table E (page 942) gives percentages of successes and failures in all three stages for the last five examinations.

In the Elementary Stage, a marked and steady improvement is evident, indicating progress in the character of the teaching, and in the attainments of the candidates. This stage has shown distinct progress in every way since its establishment in 1901, and affords very distinct evidence of advancement in the class of instruction given in the secondary schools of the London County Council, and other educational authorities throughout the country.

Table F (page 942) shows the progress made by the Elementary Examination since the Stage was established in 1901. It gives the number of candidates in each year with the number of papers worked; also the number of subjects of examination.

In the Elementary Stage the 9,196 candidates worked 11,069 papers, so that, as is always the case, a large proportion of the candidates in this, as in the higher stages, were content with a single subject. Book-keeping attracted the largest number, 3,340; next was Shorthand, 2,443. The next largest subject was Arithmetic, for which there were 1,393. In French, there were 1,258. Then comes Typewriting, for which 1,010 candidates presented themselves; in Handwriting and Correspondence, 982. In German the numbers were 348. In Commercial Geography 246. Spanish attracted 61 entries, and Italian 18. In all 7,366 certificates were granted to successful candidates, and there were 3,703 failures. It is gratifying to notice that with the considerable increase of numbers there has been a remarkable increase in the percentage of success. Commercial Geography shows a falling off of 30 from last year; in Spanish there are 17 less, and in Italian 7. All the other subjects show an increase.

Table G (page 943) gives in detail the results

of the present year's examinations. It gives the number of papers worked in each subject in each stage, with the corresponding successes and failures.

Two fresh Tables have been added to this year's Report — Tables H and K on page 944. They show the proportion of failures in each subject in the two higher stages at the examinations of the last five years, including the present year. Their object is to indicate, as far as such figures can indicate, the general standard which it is attempted to preserve in each stage. It is of course impossible to establish identical standards for different subjects. No one could say what would be an identical standard for Arithmetic, Book-keeping, Shorthand, and French. Still it is possible by the aid of experience to approximate to a similar standard, even in subjects of a totally different character, and it may be taken as certain that the same standard is fairly well preserved in each particular subject. The results of necessity vary from year to year, and it is generally the case that when there is anything like a sudden increase of numbers in a subject, the proportion of failures increases.

It may also be said, as is mentioned in another part of this report, that when the numbers upon which the percentages are based are small, the percentages themselves are practically meaningless. In those subjects in which there are only a very few candidates, no useful conclusion of any value, for purposes of comparison, can be drawn. Another point worth mentioning is that the standard is purposely kept rather lower in subjects for which there are very few entries, and which therefore seem to require encouragement. In such subjects as Russian, Danish, Swedish, Chinese or Japanese, the standard to which the candidates are expected to work has no sort of relation to the definite standard which has been established by long experience in the more popular subjects.

A report on the Practical Examinations in Music has been published in the *Journal*.* 392 candidates were examined—a decrease of 40 as compared with the 432 last year; of these 298 passed and 94 failed. These examinations have been carried on continuously since they were established in 1879. The numbers have never varied very widely. In the first year 117 candidates were examined. The numbers increased gradually to 276 in 1891, and to 393 in 1895. The largest number yet examined was 566 in 1900. During the last few years there has been a small but steady diminution in the numbers, the reason for which is not very apparent. The standard has not varied greatly, but is now a little higher than it was. The general level of attainment is considered by the examiners to have risen slightly of recent years.

* See *Journal*, July 9th, 1909, vol. lvii., p. 696.

For the Vivâ Voce Examinations held this year in Modern Languages 656 candidates entered—a slight increase on last year, when there were 613. These examinations were started in 1902, when 280 candidates were examined. The numbers rose to 681 in 1904, after that there was a slight falling off. Examinations were held this year in French, German, Spanish, and Italian; there have also in previous years been a few entries for Portuguese, but none entered this year. The numbers were—French 472, German 146, Spanish 25, Italian 13. The increase is principally in German, for which last year only 100 entered, whereas there were 146 in 1909.

The Examiner in colloquial French reports that with a slightly larger number of candidates, the percentage of successes is higher, though fewer passed with distinction. The German examiner speaks favourably of his results—102 out of 146 having passed, 32 of them with distinction. Spanish is, as last year, less satisfactory, 13 only out of 25 having passed, and only 1 with distinction. This result is unexpected, seeing how successful the written examinations in Spanish are. It is to be regretted that more of the successful candidates do not take up the study colloquially. The Italian examiner remarks on the fluency with which most of the candidates spoke. There were only 13 candidates, of whom one failed.

A report containing further details of these examinations, giving a list of the places where they were held, &c., will appear in a forthcoming number of the *Journal*.

It is much to be desired that these ~~colloquial~~ examinations should attract a larger number of candidates. Facilities for the acquirement of a conversational knowledge of foreign languages are now more abundant than formerly, and the independent test provided by the Society's examination must of necessity be useful. The certificate also must be valuable evidence of proficiency. It should be noted that these examinations are offered to students at, or probably under, their actual cost.

The examinations in Rudiments of Music and Harmony were carried on as usual at the

same time as the Commercial examinations, and the results appeared as part of the results of the Intermediate Stage. The total number of candidates shows a slight falling off as compared with last year, though a slight increase on the previous two years. This year there were 699, compared with 716 in 1908, 641 in 1907, and 632 in 1906. The falling off was in the first-named section, there being a small increase in the second. In Rudiments of Music 455 candidates presented themselves, whereas last year there were 482. In Harmony there were 244, as compared with 234. Of the 455 candidates in Rudiments of Music, 380 passed and 75 failed. Of the candidates in Harmony, 183 passed and 61 failed. The examiner, on the whole, reports favourably on the results, and indeed the proportion of successes to failures was much higher this year in both divisions of the examinations.

At the request of the Army Council, the Council in 1907 arranged to hold a special annual Examination in Shorthand for soldiers. The first examination in Shorthand was held that year, when, out of 40 candidates entering, 26 passed; the second was in April, 1908. There were in all 84 candidates, of whom 67 passed and 17 failed. A silver medal was awarded to the best candidate in the Advanced Stage.

This year the entry was not so large, there being only 60. There were 30 centres in the United Kingdom, India, South Africa, and Egypt. These examinations this year, as last, were held in April. Of the 60 candidates, 41 passed and 19 failed. In the Advanced Stage there were 2 First-class and 11 Second. In the Intermediate Stage there were 18 First and 15 Second. Though the results are not as good as last year, the percentage of successes, 75, is above the average. Last year it was 77.

Last year, also at the request of the Army Council, similar examination for soldiers in Typewriting was arranged. There were only 5 candidates, and 4 of them passed, 1 Advanced, 2 Intermediate, and 1 Elementary Grade. The solitary failure was in the Elementary Grade. The examinations were held at 3 centres in the United Kingdom. This year there were again 5 candidates, 2 in the Intermediate, and 3 in the Elementary Stage. All passed, the two in Stage II. securing First-classes. All the work was good. The Examinations were held at 4 centres in the United Kingdom and India. As the number of entries are so few, it is not intended to continue the Typewriting examinations.

The Examination Programme for 1910 was issued three weeks ago. In it will be found the fullest possible information about the Examinations, a Syllabus of each Stage of each subject, and the papers set in 1909. The attention of both teachers and students may be drawn not only to the Syllabuses but also to the remarks of the various examiners on the results of last year. It will be found that these contain many valuable and helpful suggestions, and the work of the candidates year after year shows that far too little attention is paid to them. Teachers especially should study these remarks, and be guided by them in the instruction they give to their pupils. The remarks of each examiner follow his examination paper in the Programme for each year.*

* The price of the Programme (128 pages) is 3d., post free 4½d. Copies can be obtained on application to the Secretary of the Royal Society of Arts, Adelphi, London, W.C. Programmes containing the papers set in 1905, 6, 7, 8 can also be obtained at the same price.

TABLE A.—CANDIDATES EXAMINED IN 1905-6-7-8-9.

		1905.	1906.	1907.	1908.	1909.
Commercial Knowledge.	Stage III.—Advanced	4,278	4,362	4,279	4,283	4,770
	Stage II.— Intermediate (including Theory of Music)	9,578	9,572	9,752	10,038	11,076
	Stage I.— Elementary	7,397	7,425	7,692	8,276	9,196
	Totals	21,253	21,359	21,723	22,597	25,042
Music (Practice)		418	467	457	432	392
Colloquial Modern Languages		681	644	629	615	656
Army Candidates		—	—	40	89	65
Totals in all subjects		22,352	22,470	22,849	23,733	26,155

TABLE B.

NUMBER OF PAPERS WORKED IN EACH SUBJECT OF STAGES III. AND II. IN 1905-6-7-8-9.

SUBJECTS.	1905.			1906.			1907.			1908.			1909.		
	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.
Arithmetic	154	360	514	119	512	631	107	446	553	98	544	642	139	653	792
English	83	235	318	52	282	334	60	262	322	60	293	353	74	349	423
Book-keeping	1,869	3,899	5,768	2,088	3,485	5,573	2,082	3,621	5,703	2,054	3,578	5,632	2,158	3,904	6,062
Commercial History and Geography	48	54	102	31	51	82	28	61	89	29	69	98	46	108	154
Shorthand	1,010	3,343	4.353	783	3,486	4,269	854	3.469	4.323	847	3,585	4,432	1,065	3,972	5,037
Typewriting	375	933	1,308	363	780	1,143	254	671	925	270	683	953	252	830	1,082
Economics	48	33	81	47	59	106	59	30	89	53	52	105	65	73	138
Précis Writing	105	104	209	84	154	238	72	132	204	50	102	152	62	107	169
Commercial Law	169	..	169	224	..	224	238	..	238	214	..	214	216	..	216
Accounting and Banking	208	..	208	322	..	322	302	..	302	288	..	288	369	..	369
French	441	657	1,098	491	872	1,363	473	1,046	1,519	535	1,144	1,679	655	1,374	2,029
German	180	262	442	167	268	435	152	273	425	167	271	438	175	312	487
Italian	21	12	33	16	30	46	21	17	38	21	22	43	21	22	43
Spanish	94	80	174	89	82	171	91	106	197	77	104	181	89	90	179
Portuguese	28	6	34	17	7	24	15	4	19	22	12	34	26	8	34
Russian	7	10	17	5	9	14	3	9	12	2	6	8	4	9	13
Danish and Norwegian..	4	..	4	4	5	9	4	8	12	6	3	9	9	..	9
Hindustani	..	2	2	..	..	..	..	..	..	..	1	1	..	..	..
Swedish	..	..	..	2	10	12	..	6	6	2	11	13	8	..	8
Japanese	..	3	3	..	5	5	..	..	..	..	3	3	..	..	..
Chinese	..	..	..	..	..	..	..	..	..	..	..	..	..	2	2
Totals ..	4,844	9,993	14,837	4,904	10,097	15,001	4,815	10,161	14,976	4,795	10,483	15,278	5,433	11,813	17,246

TABLE C.

PERCENTAGES OF SUCCESSES AND FAILURES, ADVANCED STAGE, 1909.

	First-class.	Second-class.	Failures.
Arithmetic	20·86	31·66	47·48
English	13·50	55·40	31·10
Book-keeping	8·20	50·37	41·43
Commercial History and Geography	17·40	32·60	50·00
Shorthand	6·66	19·44	73·90
Typewriting	17·06	53·18	29·76
Economics	24·62	50·76	24·62
Précis-writing	33·90	35·50	30·60
Commercial Law	10·64	55·56	33·80
Accounting and Banking	13·82	56·10	30·08
French	17·24	58·02	24·74
German	31·42	42·29	26·29
Italian	52·38	33·34	14·28
Spanish	27·00	44·00	29·00
Portuguese	80·80	19·20	0·00
Russian	75·00	25·00	0·00
Danish and Norwegian	44·50	44·50	11·00
Swedish	50·00	37·50	12·50

TABLE D.

PERCENTAGES OF SUCCESSES AND FAILURES, INTERMEDIATE STAGE, 1909.

	First-class.	Second-class.	Failures.
Arithmetic	23·12	41·50	35·38
English	7·45	61·32	31·23
Book-keeping	10·04	59·22	30·74
Commercial History and Geography	10·20	56·50	33·30
Shorthand	14·70	48·66	36·64
Typewriting	28·32	40·09	31·59
Economics	23·30	49·30	27·40
Précis-writing	22·43	45·79	31·78
French	9·32	61·35	29·33
German	9·94	43·91	46·15
Italian	50·00	32·00	18·00
Spanish	32·22	41·12	26·66
Portuguese	62·50	37·50	0·00
Russian	33·33	33·33	33·34
Chinese	50·00	50·00	0·00

TABLE E.

PERCENTAGES OF SUCCESSES AND FAILURES IN ALL STAGES 1905-6-7-8-9.

Advanced (Stage III.).

	1905.	1906.	1907.	1908.	1909.
First-class	14·20	12·86	15·00	12·99	12·60
Second-class	51·00	49·92	47·80	51·95	44·60
Failures	34·80	37·22	37·20	35·06	42·80

Intermediate (Stage II.).

First-class	17·00	20·77	19·45	22·60	13·31
Second-class	50·40	47·32	50·25	50·40	53·75
Failures	32·60	31·91	30·30	27·00	32·94

Elementary (Stage I.).

Passes	57·00	59·39	59·62	64·45	66·54
Failures	43·00	40·61	40·38	35·55	33·46

TABLE F.

ELEMENTARY EXAMINATIONS, STAGE I.

Year.	No. of candidates.	No. of papers worked.	No. of subjects.
1901	3902	4458	8
1902	4371	4807	8
1903	5382	6020	8
1904	6401	7203	9
1905	7397	8427	10
1906	7425	8537	10
1907	7692	8952	10
1908	8276	9811	10
1909	9196	11069	10

TABLE G.—Showing the detailed results of the 1909 Examinations held at 414 Centres.

Subjects.	Stage III.—Advanced.				Stage II.—Intermediate and Music.							Stage I.—Elementary			Total number of papers worked in all stages.
	Papers worked.	1st class certificates.	2nd class certificates.	Not passed.	Papers worked.	1st class certificates.	2nd class certificates.	Music Certificates. Higher.	Music Certificates. Inter-mediate.	Music Certificates. Elemen-tary.	Not passed.	Papers worked.	Passed.	Not passed.	
Arithmetic	139	29	44	66	653	151	271	..	..	..	231	1,393	869	524	2,185
English	74	10	41	23	349	26	215	..	..	..	108	..	..	..	423
Book-keeping	2,158	177	1,087	894	3,904	392	2,312	..	..	..	1,200	3,340	1,889	1,451	9,402
Commercial History & Geography	46	8	15	23	108	11	61	..	..	..	36	..	..	..	154
Commercial Geography	..	..	..	..	..	..	..	..	..	..	..	216	136	80	216
Shorthand	1,065	71	207	787	3,972	584	1,933	..	..	..	1,455	2,443	1,916	527	7,480
Typewriting	252	43	134	75	830	160	441	..	..	..	229	1,010	698	312	2,092
Economics	65	16	33	16	73	17	36	..	..	..	20	..	..	..	138
Précis-writing	62	21	22	19	107	24	49	..	..	..	34	..	..	..	169
Commercial Law	216	23	120	73	..	..	..	..	..	..	..	..	..	..	216
Accounting and Banking	369	51	207	111	..	..	..	..	..	..	..	..	..	..	369
French	655	113	380	162	1,374	128	843	..	..	..	403	1,258	889	369	3,287
German	175	55	74	46	312	31	137	..	..	..	144	348	247	101	835
Italian	21	11	7	3	22	11	7	..	..	..	4	18	16	2	61
Spanish	89	24	39	26	90	29	37	..	..	..	24	61	48	13	240
Portuguese	26	21	5	..	8	5	3	..	..	..	..	..	..	..	34
Russian	4	3	1	..	9	3	3	..	..	..	3	..	..	..	13
Danish and Norwegian	9	4	4	1	..	..	..	..	..	..	..	..	..	..	9
Swedish	8	4	3	1	..	..	..	..	..	..	..	..	..	..	8
Chinese	..	..	..	..	2	..	2	..	..	..	..	..	..	..	2
Handwriting and Correspondence	..	..	..	..	..	..	..	..	..	..	..	982	658	324	982
Rudiments of Music	..	..	..	..	455	..	..	204	..	176	75	..	..	..	455
Harmony	..	..	..	..	244	..	..	30	73	80	61	..	..	..	244
Totals	5,433	684	2,423	2,326	12,512	1,572	6,350	234	73	256	4,027	11,069	7,366	3,703	29,014

Table H.

Percentages of Failures in all Subjects, Advanced Stage, 1905–6–7–8–9.

	1905.	1906.	1907.	1908.	1909.
Arithmetic	33·12	33·62	25·23	33·67	47·48
English	38·55	36·50	40·00	41·50	37·10
Book-keeping	31·35	36·10	32·04	33·93	41·43
Commercial History and Geography	45·84	48·40	32·14	37·93	50·06
Shorthand	44·00	52·69	62·18	45·70	73·90
Typewriting	34·00	33·61	31·10	23·70	29·76
Economics	27·00	25·53	30·51	32·07	24·62
Précis-writing	50·50	40·48	41·67	28·00	30·60
Commercial Law	44·40	37·06	30·45	43·00	33·80
Accounting and Banking	29·33	31·06	32·12	30·21	30·08
French	28·30	30·55	30·45	31·96	24·74
German	37·30	28·70	27·00	34·73	26·29
Italian	4·80	18·75	14·40	14·28	14·24
Spanish	30·75	34·83	35·15	27·27	29·00
Portuguese	0·00	11·70	0·00	0·00	0·00
Russian	14·30	0·00	0·00	0·00	0·00
Danish and Norwegian	0·00	0·00	25·00	16·66	11·00
Swedish	..	0·00	..	0·00	12·50

Table K.

Percentage of Failures in all Subjects, Intermediate Stage, 1905–6–7–8–9.

	1905.	1906.	1907.	1908.	1909.
Arithmetic	29·00	37·89	34·50	34·38	35·38
English	34·10	26·25	36·30	37·54	31·23
Book-keeping	26·39	24·71	27·34	23·31	30·74
Commercial History and Geography	33·34	35·20	50·80	33·33	33·30
Shorthand	42·00	38·52	27·70	26·15	36·64
Typewriting	32·68	31·92	31·59	22·26	31·59
Economics	18·14	32·20	26·67	30·77	27·40
Précis-writing	40·38	35·07	43·94	33·33	31·78
French	24·35	32·33	29·64	20·00	29·33
German	24·44	34·33	35·53	35·00	46·15
Italian	8·30	20·00	23·55	13·00	18·00
Spanish	38·75	18·29	35·84	27·90	26·66
Portuguese	0·00	38·57	0·00	0·00	0·00
Russian	30·00	33·34	44·45	0·00	33·34
Danish and Norwegian	..	20·00	0·00	9·09	..
Swedish	..	60·00	83·33	0·00	..
Japanese	66·60	100·00	..	33·34	..
Hindustani	50·00	..	..	0·00	..
Chinese	..	..	..	..	0·00

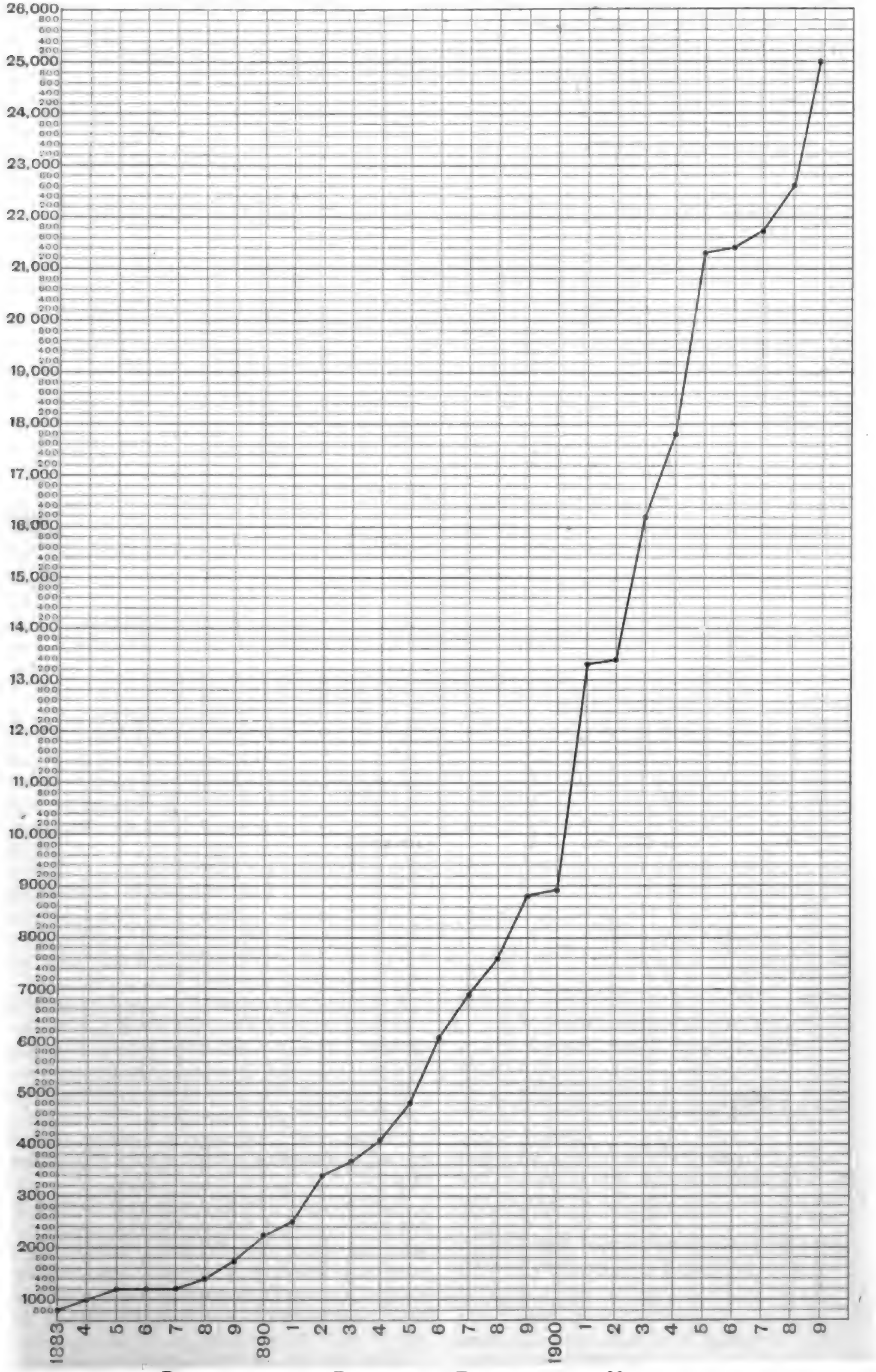

Diagram showing Progress of Examinations, 1883 to 1909.
(Numbers of Candidates.)

THE RELATIONSHIP OF MANURING TO MEAT PRODUCTION.*

It has long been known that a large increase of herbage is secured from many classes of grass land through the use of certain artificial manures, but in most cases the effects of the manures have been tested by simply weighing the increase secured. Sometimes the investigation has been carried further, and the herbage grown with and without manure has been separated into its constituent plants, and an attempt has been made to estimate the improvement in quality by the increase of such plants as clovers, and the suppression of such plants as sorrel and other weeds. In addition to such a botanical separation the herbage has sometimes been submitted to chemical analysis, and an attempt has been made to gauge the feeding value by the percentage and absolute weight of proteids, fats, and carbohydrates, and by the digestibility of the fibre. All these methods convey useful information, but as the ultimate object of producing herbage is to feed animals, and as no laboratory method can perfectly interpret the processes in an animal's stomach, it occurred to me that useful information might be got by utilising the animals themselves to pass judgment on the results.

My work has been chiefly confined to experiments on grass-land, and on grass-land they have been chiefly concerned with pasture as opposed to hay. In the United Kingdom there are some 34,000,000 acres under grass (apart from mountain grazings), and of this, 24,000,000 acres are grazed and 10,000,000 are cut for hay. Clearly, therefore, the grazed area is of much more importance than that which is used for hay. To exclude stock from plots on a pasture, and to test the results of applying manures by weighing and analysing the herbage, must lead to a fallacious conclusion, for the reason that the mere exclusion of the stock encourages one set of plants and represses another, and the experiment resolves itself into one not on pasture, but on hay.

In 1896 the county of Northumberland rented a farm (Cockle Park) of 400 acres, of which I was given the scientific direction. A clay-field of uniform character, that had been under pasture of a poor type for many years, was divided by fences into ten plots of $3\frac{1}{10}$ acres each. Three acres of each plot had been grazed by sheep each summer for the past thirteen years, the herbage of the sub-plot of $\frac{1}{10}$ acre being annually made into hay. Specially selected sheep have been used for grazing the plots, the animals being individually weighed at the beginning of each season, and monthly during the progress of each grazing season. The health of the sheep on the comparatively limited grazing area of three acres has been all that could be desired, and any individual idiosyncracies have been eliminated by the number of sheep (usually six to twelve) that grazed each plot. The system of experiment ("manuring for mutton") and the results have attracted a large amount of attention, and, aided by the Board of Agriculture, the experiments have been repeated, in part or in whole, in several parts of England and Scotland. It is only necessary here to call attention to the leading results, and chiefly to those obtained during the first nine years, the scheme being primarily designed to cover that period.

Lime has been used in two ways: (1) In two dressings of 4 tons per acre, and (2) in three dressings of $\frac{1}{2}$ ton per acre as a supplement to superphosphate. The former system is a very old one and popular with farmers, but neither at Cockle Park nor elsewhere have the experiments shown it to be efficacious or profitable. At Cockle Park it only accounted for an average annual live-weight increase (which, for short, may be called mutton) of 12 lb. per acre. Under the second method the $1\frac{1}{2}$ tons of lime have produced an average annual increase of 22 lb. of mutton, and have left a small profit, as against a large loss in the other case. Basic slag, used in the first year only, at the rate of 10 cwt. per acre and a cost of 23s. 6d., has produced an average annual increase of 80 lb. of mutton. Valuing this at $3\frac{1}{2}$d. per lb., and deducting the cost of the manure, it means that a single expenditure of 23s. 6d. has given a clear annual gain of 22s. 3d., or nearly 100 per cent. per annum, and even at the end of nine years the effects of the slag are by no means exhausted. On an adjoining plot 10 cwt. of basic slag had also been used, 5 cwt. being put on the first year and 5 cwt. at the end of the third. This method of treatment has produced an average increase of 66 lb. of mutton, and although the profit here has also been large (averaging 18s. per acre per annum), it is considerably short of that secured under the other method of using the same manure. This result has been confirmed at the other duplicate stations, and shows that it is better to stimulate the superior plants by a large initial dose of phosphates than to spread the use of the phosphates over a longer period.

When the source of phosphoric acid was superphosphate instead of basic slag the cost was considerably greater, and the actual weight of mutton produced was distinctly less (57 lb. per acre per annum as against 66). The annual profit was therefore reduced from 18s. to 13s. 9d. per acre.

Adding potash to phosphate increased the yield of mutton to the extent of just covering the outlay involved.

When nitrogen in the form of sulphate of ammonia was used the yield of hay was increased some 25 per cent., but the annual production of mutton was actually reduced from 57 to 54 lb. per acre per annum. This result was also obtained at all the stations, and shows how far mere weighing of the herbage may lead one astray.

Other manurial substances (cakes, residues, and dissolved bones) were also tried, but the results of

* Abstract of a paper read by Professor Somerville before the Agricultural Sub-Section of the British Association at Winnipeg, 1909.

these, being more complicated, need not be discussed. Mention may, however, be made of the fact that at Cockle Park at the end of the ninth year a further dose of 10 cwt. of basic slag was applied per acre to the plot that had received a similar dose nine years previously, and the effects were seen in a large increase of mutton in the following years (1906, 1907, and 1908). This proves that there is little ground for the popular belief that grass-land fails to respond to a second application of a phosphatic manure. At one of the duplicate stations basic slag was applied to a plot in the middle of June, and before the grazing season was over the effects were clearly reflected in the growth of the sheep and in the appearance of the pasture. In the following year this plot, which had been the worst of the series, became the best. The opinion hitherto held that an insoluble phosphate, like basic slag, should be applied some months ahead of the growing season, must therefore be revised, equally good results following application when the herbage is in vigorous growth.

These experiments seem to show that probably no crop on the farm offers opportunities for more profitable use of artificial manures than poor worn-out pasture.

MARBLE WOOD OR ZEBRA WOOD.

The Government of India are issuing a series of short monographs dealing with some of the more important India timbers, and one entitled "Andaman Marble Wood or Zebra Wood" (*Diospyros Kurzii*, Hiern), by Mr. R. S. Troup, F.C.H., Imperial Forest Economist to Government, supplies information about a valuable product but little known in this country. The tree, which is an evergreen, is distributed throughout the Andamans, and is also found in the Nicobars and Coco Islands, in semi-deciduous and evergreen forests at elevations of about 50 to 200 feet above the sea. It grows to a height of from 40 to 60 feet, and a girth of 5 or 6 feet. Like the "calamander wood" of Ceylon, marble wood is a variegated ebony, the chief value of which for ornamental purposes lies in the remarkable effect produced by alternating streaks of black and grey. Mr. Troup sent samples of the wood to Mr. Herbert Stone, of Birmingham, the well-known specialist on timbers, and the latter reported that the wood was well-known in England to turners and makers of "Tunbridge ware," but that it is surprising how rarely one sees it in use. Mr. Stone could not recall having seen a piece of furniture in which marble wood was used. Nevertheless it is highly spoken of by men in the trade, and there can be no doubt that all that could be sent over to England would be readily bought up. The greater the contrast between the darker and lighter bands the more valuable would the timber be. It is a true turner's wood and when polished has a very fine effect. Altogether Mr. Stone and the experts he consulted considered it one of the handsomest timbers in the world. In the present monograph there are photographic illustrations of fifteen specimens, and one can quite realise the statement that the wood readily takes a high and fine polish. In seasoning it requires great care, but the marble wood planks received by the author from the Andamans have shown less tendency to warp and split than many other Indian woods. A small trial consignment of 8½ cwt. sold a great many years ago in London fetched at the rate of £2 15s. per ton weight, but regular consignments at the present time would probably bring a much higher price. The forests of the Andamans and other islands being practically unexplored it is impossible to estimate the future out-turn. At the same time it might prove well worth while exploiting the woods, for so handsome a wood is peculiarly suitable for cabinet work, ornamental furniture, walking sticks, fancy-boxes, carving, turning, inlaid work, picture frames, &c. Enquiries regarding the timber should be addressed either to the Deputy Conservator of Forests, Port Blair, Andamans, or to the Imperial Forest Economist, Dehra Dim, United Provinces, India.

ORIENTAL STUDIES.

The Report of the Committee, appointed by the Treasury as far back as April, 1907, to consider the organisation of Oriental Studies in London, was issued as a Parliamentary Paper (Cd. 4560) on the 25th inst. A very full report of it appears in *The Times* of the 27th.

The Committee recommend the establishment in London of a School of Oriental Languages, under the control of the University of London. The estimated annual cost of the proposed school is £12,725 a year, and an initial grant is also suggested. The staff proposed includes a director, five professors, nine readers, sixteen native assistants, librarian, secretary, &c. The languages in which it is suggested that instruction should be given in the first case are Turkish, Arabic, Persian, Hindi, Hindustani, Bengali, Marathi, Gujarati, Tamil, Telugu, Kanarese, Burmese, Malay, Chinese, Japanese, Swahili, and Hausa; and it is suggested that later on instruction may also be required in Assamese, Punjabi, Tibetan, Pashto, Cinhalese, Melanesian and Polynesian languages, Siamese, Amharic, Luganda, Somali, Yoruba, and Zulu.

Attention may be drawn to the fact that for many years past this Society has endeavoured to encourage the study of Oriental languages by offering to hold examinations in them. Syllabuses have been prepared, and issued in the Examination Programme, for Japanese, Chinese, and Hindustani. Medals and money prizes have been offered in each subject. Nevertheless the number of candidates has been absolutely insignificant. For many years there were

none at all, and during the past five years or so there have been only one or two candidates in each subject. The response to the offer having been so extremely poor, the Society has never been encouraged to organise examinations in other Oriental languages, though it certainly would have been prepared to have done so had there been any probability of an adequate response. It is to be remembered that the examination of one or two candidates involves a pecuniary loss, since the expense incurred is very much the same as for a larger number.

THE EVOLUTION OF A BREED OF CATTLE.*

Nearly every breed of cattle is a combination of several breeds: a result of crossing again and again and of subsequent "pure" breeding. The modern Aberdeen-Angus breed is a case in point. It is the result of perhaps fewer crossings than some other breeds; but the ingredients used in its production are so decidedly varied, that a consideration of the way in which it has been formed yields the most highly instructive results.

In addition to the Urus, which became extinct in the Bronze Age, half a dozen different kinds of cattle have come to Britain at different times—viz., (*a*) the black Celtic race, which came in before the Urus was extinct; (*b*) the "brown" race, black with a brown stripe along the back and a tan muzzle, which probably came with the Belgæ; (*c*) the white race, brought in by the Romans; (*d*) the red race, brought in by the Anglo-Saxons; (*e*) the hornless race, brought in by the Norsemen; and (*f*) the large flecked race imported from Holland in the seventeenth and eighteenth centuries.

When the Norsemen brought over their hornless cattle the rest of Scotland was occupied by the black Celtic race, with a considerable infusion of brown Belgæ and a smaller infusion of white Romans. These were all horned. In the eighteenth century many large cattle of the Dutch flecked race were taken to the North-East of Scotland and crossed with the small native cattle, with the result that the native cattle gradually acquired the size of the flecked cattle. All this time the Norse cattle had been holding the sea-boards of Forfar, Kincardine, Aberdeen, and Banffshires. In the middle of the eighteenth century a demand arose in England for hornless cattle; and to meet this demand the farmers in the North-East of Scotland crossed their horned cattle with the Norse hornless ones, with the result that the horns of the horned ones were removed. By selecting breed stock that were black in colour, large in size, and hornless, the North-East farmers eliminated the undesirable characters of the various races of cattle that had been introduced to their country, and eventually produced their present breed.

* Abstract of a paper read by Professor J. Wilson, B.Sc., before the Agricultural Sub-Section of the British Association at Winnipeg. 1909.

HOME INDUSTRIES.

The Insurance of the Poor.—The opposition to the Assurance Companies Bill grows, and it may be hoped that the Government will not press it through the House of Commons this year. It has passed the House of Lords, but Lord St. Aldwyn and other peers expressed considerable doubt as to whether it was well considered. Lord St. Aldwyn spoke of it as a "whitewashing Bill," and that accurately describes it, in so far as it relates to industrial insurance. As all know, there are great abuses in connection with this branch of insurance business. Large sums are taken from the working-classes every year by industrial insurance companies, who give a very inadequate return, or none at all. In a case recently before the Courts it was proved that the plaintiff had paid over £91 in return for a possible £35. For loans, where it is impossible for the company to lose, as much as 10 per cent. interest is charged. In the case of policies where there is no insurable interest some of the companies instruct their agents to fill in the object of the insurance as "funeral expenses;" and the agents do not hesitate to forge the signatures of persons upon whose lives assurances have been proposed without their knowledge by other persons. In one case tried during the past summer, forging of the signature of the person who was insured by the agent, and absolute ignorance by the assured until many years after, were proved. The company went to the Court of Appeal, which, without hesitation, dismissed the appeal with costs. In his judgment the Master of the Rolls, referring to the agent concerned, said, "Now what is the position of this man? He is a superintendent of the company, and he is appointed under the terms of a written appointment containing a clause which puts a temptation in the way of a superintendent to which a superintendent ought never to be exposed. It is part of the terms of his appointment that it is his duty to increase the business of the company in his superintendency not less than 6s. per week. That is a frightful temptation to put in the way of a superintendent, and an inducement to him to go, as this one did to the plaintiff, and to obtain a proposal from him regardless whether there was any 'insurable interest.'" It is not too much to say that there are hundreds and thousands of industrial insurance policies taken out every year that are fraudulent, policies where the signatures are forged, policies where there is no insurable interest, policies taken out owing to all sorts of false representations. The Attorney-General recently admitted in Parliament that these abuses exist. Of course, the Insurance Companies' Bill now before the House of Commons will not legalise fraudulent representation of any kind, but if it becomes law it will make effective a vast number of policies that are now avoidable, and will legitimatise much of the gambling in lives that now takes place. It proposes to repeal the Act of George III. which prohibits insurance of lives when the persons insuring have no interest in the life

or death of the persons insured, and to extend to what experts consider dangerous lengths "insurable interest." The Parliamentary Committee of the Trades Unions are at one with Lord St. Alwyn in their distrust of some of the clauses of the Bill: lawyers are equally opposed to them; and it is much to be hoped that the Government will postpone the passing of the Bill, or at any rate the controversial clauses to which reference is here made, until a Select Committee has had the opportunity of examining and reporting upon them.

Agricultural Returns.—The Preliminary Statement for 1909 shows that the conversion of arable land into pasture, and the reduction of the agricultural areas, which have been such marked features of the last thirty years continue, but last year the shrinkage was smaller than in preceding years. The total extent of arable land which about thirty-five years ago amounted to 18½ million acres has now fallen to 14,730,668 acres (as compared with 14,795,517 acres in 1908). On the other hand the area under wheat shows marked increase, 1,823,563 as against 1,626,753 acres. The comparison is between 1909 and 1908, and it may be expected that with the continuance of high prices there will be a further increase in the coming year. The area under barley shows a slight falling off, 0·2 per cent., and under oats 4·1 per cent., but the acreage under peas increased no less than 20,171 acres, or 12·3 per cent. It is satisfactory to note that the area under small fruit continues to increase. In 1908 2,705 acres were added, and this year there is a further increase of 2,236 acres, or 2·6 per cent. The hop area continues to shrink. In 1908 the acreage of hops returned was 6,017 acres below that of 1907, this being the largest decline recorded in any year except 1887, when the loss amounted to 6,421 acres. This year the acreage has shrunk to 38,921 acres, the decrease as compared with last year being 6,382 acres, or 16·4 per cent. The number of pigs returned in 1908 was 2,823,432, being 186,716, or 7·1 per cent. more than in 1907, but this increase has now been much more than lost, the number having fallen to 2,380,887, or no less than 15·7 per cent. The changes in the other descriptions of live stock have not been important. The total of cattle shows a decline of 1·7, of sheep 1·8, and of horses 0·5 per cent.

The Wool Trade.—The present high prices for wool can hardly be maintained. Some of the largest users in the West Riding have decided not to order the purchase of a single bale in any of the Australian markets during the present season, or, at any rate, until prices have sensibly dropped from their present level. They prefer to risk the London market, and will only buy from hand to mouth. It is admitted generally that big increases are assured from all the sources of supply in the southern hemisphere. The chairman of the United Pastoralists' Association, of Queensland, in his address to the members, said that he considered the number of sheep in the State had increased by about 10 per cent., thus making the number upwards of 20,000,000. He anticipated that the highest record would be reached by the end of the year. Since the end of the great drought in 1902, the number of sheep depastured in Queensland has trebled, and as the breed of sheep has been greatly improved, it is to be assumed that the clip of wool has increased in a greater ratio than the number of sheep. Advices state that the sheep are cutting unusually heavy fleeces of sound, deep-stapled wool, and it should be borne in mind that an increase of only one pound in the weight of each fleece would mean an increase in wool exports from the Commonwealth of over 200,000 bales.

The Milk Supply.—Dr. A. G. Anderson, who has given many years to the investigation of the conditions of the cowsheds, dairies, and milk supply of Rochdale, of which town he is Medical Officer of Health, has published an important report upon the production and supply of milk from the point of view of health. One of his main points is that "the great source of contamination is the cowshed, the cow, the milker, and the utensils, and the only reasonable and logical solution is to remove the evil at its source by the establishment of a higher standard of cleanliness." Within the borough of Rochdale there are 75 farms providing milk. They contain 137 cowsheds with 1,207 cows and they are classified as follows:—good, 30; fair, 39; bad, 68. Dr. Anderson found that the larger the farm the better the conditions, for the average number of cows to each "good" cowshed is 13·33; to the fair, 10·74; and to the bad, 5·70. He believes that apart from and in conjunction with legislation much might be done by private enterprise and education, and he points to what has been done by certain companies in Denmark, in England, and in America. The farmers supplying milk to these companies have to agree to certain conditions of contract, for the contravention of which there is a heavy penalty, £100 in some cases. The cows have to be warranted free of disease and examined for tuberculosis by the tuberculin test; the conditions of cowshed, lighting, ventilation, cleansing, drainage, water supplies, cleanliness of milkers, cooking and straining milk, chemical and bacteriological tests, protection of milk from infection, and other standards are distinctly laid down, and to ensure that these conditions are observed the inspectors of the companies regularly visit the farms. Dr. Anderson recommends the institution in Rochdale of one of the depôts for the sale of milk which under the Milk and Dairies Bill the local authorities are authorised to establish; he believes that apart from the supply of good milk to babies it would educate public opinion, and act as an inspiration and stimulus to many farmers and dairymen who may care to learn the science of the business.

The Shipowner as Common Carrier.—Is the shipowner a common carrier? In theory yes, in practice no. The question is raised by Mr. Arthur Cohen, K.C., in one of the Appendices of the Report of the Royal Commission on Shipping Rings. It was, he says, established by Nugent *v.* Smith and other cases that a shipowner's liability at common law is the same as that of a common carrier, so that in the absence of any stipulation to the contrary a shipowner is bound to carry the goods safely, and deliver them at their port of destination, and is responsible for any loss or danger, the act of God excepted. But in practice this liability disappears, since the shipowner is free to enter into a contract with a single shipper, practically excluding any and every other shipper from the transaction. Mr. Cohen puts the law in this way:—"According, then, to English law, the shipowner's liability is, in the absence of argument to the contrary, that of a common carrier, which is substantially the same as that of an insurer of goods. A merchant can indeed require the shipowner to carry his goods, as, and with the liability of a common carrier, on tending to him a reasonable freight. In fact, however, no merchant ever desires or requests his goods to be carried on those terms, and would never tender the proper freight for the purpose." The law holds the shipowner to be a common carrier, but he is never asked to trade in that capacity, and so in fact he is not a common carrier.

CORRESPONDENCE.

EMPIRE NOTES.

I see in your September number a good feature entitled "Empire Notes." The States and Provinces of the Empire deserve to be brought forward on every possible occasion, and indeed are receiving much attention. I am particularly at present interested in Army Pensioners desirous of commuting their pensions and going to New Brunswick. I enclose note of an excellent scheme we have devised for their benefit. Officers, as well as non-commissioned officers, &c., can avail themselves of it. No other Government has offered anything so favourable.

W. M. Graham Easton,
Secretary.

Norfolk-house, Office of Agent-General for New Brunswick,
Laurence Pountney-lane, London.
September 27, 1909.

Mr. A. B. Wilmot, Superintendent of Immigration, St. John, N.B., to Mr. W. M. Graham Easton, Secretary, New Brunswick Agency-General, London. July 17, 1909.

Commuted Pensions.—I had a conversation with the Premier *re* this matter, and he agrees that there would be no difficulty about safeguarding the settlers' money. An arrangement may be made whereby the commuted pensions may be transferred to the office of the Receiver-General for New Brunswick, and have a separate account opened with each settler. Three per cent. interest will be allowed by the Government on the balance of all the money that is deposited. The Government will appoint a Board of three members, one of whom shall be a member of the Executive Council, upon whose recommendation money may be withdrawn by any pensioner for purposes approved of by the Board. It can be arranged with the Secretary of the Board to report to the Home authorities in regard to each pensioner, say every six months. The Board would naturally make every effort to get each settler located under conditions giving promise of the best results. If the pensioner decides, after remaining in the Province for a year, that he would prefer to locate in some other part of His Majesty's Dominions, the transfer of his property and effects can be arranged with the approval of the Home authorities. I see no difficulty in arranging for a perfectly workable system.

GENERAL NOTES.

Swiney Lectures on Geology.—A course of twelve lectures on "The History of North-West Europe during Tertiary Times" will be delivered by T. J. Jehu, M.A., M.D., F.R.S.E., in the lecture theatre of the Victoria and Albert Museum, South Kensington, on Mondays and Tuesdays at 5 p.m., and Saturdays at 3 p.m., beginning Saturday, 6th November. They will be in connection with the British Museum (Natural History). The lectures will be given under the Swiney Trust, and will be illustrated by lantern slides and the lime-light. Admission to the course is free.

Railways in Spain.—In his report on the trade of Bilbao (No. 4341, Annual Series), Mr. Consul Maclean says that a Royal Order has recently been gazetted to clear up doubts that had arisen as to the items which could be properly included under the "cost of construction," on which by the law of March 26, 1908, the Spanish Government guarantee 5 per cent. interest. This Royal Order authorises the inclusion of cost of rolling stock, surveys, plans, and accumulated interest on disbursements during period of construction—as stipulated in concession—at the rate of 5 per cent. per annum. It seems, says the Consul, to be the impression of the British Chamber of Commerce for Spain that it would be worth while for financiers and railway contractors who may be inclined to invest capital in Spain to make a careful investigation of some of the projects scheduled in the above-mentioned law. In connection with some of the projected railways it may possibly be found that local authorities, municipalities, and landowners interested would be willing to grant facilities and give valuable assistance.

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FRIDAY, OCTOBER 8, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

STEAM TURBINES.

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Lecture I.—Delivered March 22nd, 1909.

In considering the subject of steam turbines and their development during the last twenty-five years, it may be worth while considering the question of prime movers in general.

Man has from the earliest times sought to utilise other powers to supplement his own, and to help him in his work. In the Bible, we read in Genesis, "Jacob put his sons and wives upon camels," and the use of horses and other animals to help man by drawing loads, or carrying him, dates from the earliest times; but the use of steam in a practical form dates from about the middle of the eighteenth century. The most notable of the early engines was Newcomen's, in which steam under low pressure was admitted under a piston which rose doing little or no work, and then, when the steam was condensed by a water jet in the cylinder, the vacuum formed sucked the piston down. The top of the cylinder was generally open to the air, and water was supplied above the piston to keep it

air tight. These atmospheric engines were largely used for pumping, and the coal consumption was somewhere about 20 lbs. per horse-power hour.

James Watt, about the middle of the eighteenth century, saw that this large coal consumption was due, in a great degree, to cylinder condensation, and after trying the effect of lining the cylinders with wood to form a non-conducting lining, he hit upon the happy idea of carrying on the condensation of the steam, not in the cylinder itself, but in a separate vessel. This was, in fact, the invention of the separate condenser. At the same time, the cylinder was closed in so that there was steam, not air, above the piston. These improvements reduced the coal consumption to somewhere about $\frac{1}{4}$th to $\frac{1}{3}$rd of what it had been before, or to between 5 and 7 lbs. per horse-power hour, and at once enabled the steam engine to take its place among the great prime movers of the world.

This Watt engine remained, in principle, without improvements except in detail until the middle of the last century, when, owing to the gradual rise of steam pressure, and consequent extra expansion, compound engines began to be introduced. This was also helped at sea by the introduction of the surface condenser, without which, giving as it does fresh water to the boilers, it was impossible to use above 25 or 30 lbs. steam pressure. As engineers gradually got better materials, and more experience was gained, steam pressure increased, and the triple and finally the quadruple expansion engines were introduced with the object of increasing the expansion ratio. It has, however, been found that unless there is a steam pressure of about 7 lbs. per square inch upon the low pressure piston, the size and cost of the low pressure cylinder become excessive, and therefore the reciprocating engine is limited practically to about 16 expansions, and this is apparently about the limit of efficiency of reciprocating engines. With modern steam pressures, the consumption of coal per horse-power hour is reduced to from $1\frac{1}{2}$ lbs. to $1\frac{1}{4}$ lbs. per horse-power or some $\frac{1}{4}$th to $\frac{1}{3}$rd of that of the fuel consumed in the time of James Watt, and some $\frac{1}{15}$th of that used in the time of Newcomen.

The gain by going to higher steam pressures than the modern ones of 180 to 200 lbs. per square inch is not much, but a considerably greater gain is easily seen to be made by going to lower pressures, that is, utilising higher vacua, and this is what the steam turbine enables one to do. It therefore has always seemed to me that the greatest step in the improvement of the steam engine which has taken place since Watt's time, and Watt's invention of the separate condenser, has been the introduction of the steam turbine in a practical form.

It has been found that in the reciprocating engine there is little use, considering the temperature at which the feed water is returned to the boiler, in going to a better vacuum than 25″. With the steam turbine, vacua of $28\frac{1}{2}$″ or 29″, or absolute pressures of from $\frac{3}{4}$ to $\frac{1}{2}$ lb. per square inch, can be easily utilised, as the difficulty of dealing with large volumes of steam does not occur in the case of the steam turbine as in the case of the reciprocating engine, and it has been found that with the steam turbine the gain due to vacuum goes steadily on up to the highest attainable vacua. Between 25″ and 26″, or 26″ and 27″, there is a gain of about 4 per cent.; a further gain of 5 per cent. is made with the vacuum increased to 28″, and a still further gain of 6 to 7 per cent. when it is increased to 29″.

This is more easily understood if we consider that the theoretical power to be derived from the steam is almost proportional to the logarithm of the expansions, and thus practically the same power can be obtained working from 400 lbs. to 1 lb. absolute, or 28″ vacuum, as from 200 lb. to $\frac{1}{2}$ lb., or 29″ vacuum. In each case there are 400 expansions by pressure, and in each case the theoretical consumption of steam by Clausius' cycle would be about 9·3 lbs. per kilowatt hour. With 150°F. superheat this would come down to 8·7 lbs., and under the conditions of 200 lbs. pressure and 29″ vacuum with 150°F. superheat, 13·2 lbs. per kilowatt hour has actually been obtained with an overall efficiency, including the alternator, of about 66 per cent., or $71\frac{1}{2}$ per cent. on the turbine shaft, allowing for the electrical losses. Professor Ewing, in his book on "The Steam Engine," gives a list of principal results obtained from condensing reciprocating engines, and in no case does the ratio of the consumption of steam by Clausius' cycle, compared with that used per indicated horse-power, exceed 64 per cent. As the ratio of brake horse-power to indicated horse-power is never more than 90 per cent., this means an efficiency at the engine shaft of not more than 58 per cent. When it is remembered that the figure obtained in the case of the turbine was 71 per cent., and further that the reciprocating engine is unable to take advantage of high

vacua, it is easily seen where the advantage of the turbine, especially in large sizes, comes in.

In all machinery with reciprocating parts heavy foundations are required, and in many cases the trouble due to vibration is considerable, especially in the case of quick-running engines. As an example, in 1894 the reciprocating engines at the Manchester-Square Station of the Metropolitan Electric Supply Company caused so much annoyance on account of vibration that the Company were threatened with an injunction, and the substitution of turbines for the reciprocating engines saved the station from being shut down. Besides that, especially in large sizes, the cost of repairs and attendance is much less, while the space occupied is only about one-third or one-quarter of that required for reciprocating engines. In very large sizes it has been found practically impossible to make reciprocating engines satisfactory, and it may not, perhaps, be generally known that one of the reasons which led the Cunard Committee to adopt turbines for the great express steamers *Lusitania* and *Mauretania* was the fact that the engineering difficulties of the enormous reciprocating engines required made the problem almost impossible of solution without the use of turbines.

Steam turbines may be divided into two great divisions—single and compound. In the former class there is the De Laval, in which the whole of the expansion is carried out in a single jet impinging on a wheel rotating at a high velocity. In order to get efficiency, the highest possible velocity for the wheel has to be attained, reaching in the larger sizes some 1,200 ft. per second, above which it is practically impossible to go on account of the centrifugal forces, and this means a speed of rotation too high for the dynamo or other machine to be driven by it. The result is that gearing has to be used to reduce the speed of rotation, and this limits this class of turbine to small sizes—not, as a rule, exceeding 200 or 300 kilowatts.

The second-class is that universally adopted for all large turbines, in which the expansion of the steam is carried out in stages. If the expansion is divided up into a number of steps the velocity of the steam is greatly reduced, and thus not only can the surface velocity of the turbine wheels be reduced but also the speed of revolution, and cutting action of the steam is prevented, for high velocity steam jets are able to cut away the hardest steel. Even yet in some classes of turbines with few stages there is still cutting action on the blades.

The compound turbine naturally divides itself into two sub-classes, those in which the expansion of the steam takes place both in the fixed and moving blades, and those in which it takes place in the fixed blades only. Included in the former class is the Parsons, while the latter contains the Rateau, Zoelly, Curtis, and various others. In the Rateau and Zoelly, which strongly resemble one another, the velocity of the steam at each stage is taken up by a single row of blades mounted on a wheel, and in the Curtis by a wheel having two or more rows of moving blades with guide blades between. There are also various combinations of these, especially those with a Curtis high pressure part and a Parsons low pressure, but as yet they have not come largely into use.

And now I may perhaps be allowed to say a few words on the origin of the steam turbine on land, which dates from 1884, when Mr. Parsons made his first turbine of about 10 horse-power.

The first steam turbine Mr. Parsons made is in the South Kensington Museum, close to the Rocket and other historic engines, and Fig. 1 shows two rows of the blading of a Parsons' turbine. The steam enters the fixed blades at the top, and impinges in a series of jets on the moving blades, driving them round as shown by the arrow. Passing through the moving blades the steam issues from them in a series of jets, which by their reaction again help to drive round these moving blades. Then it passes on to the next row of fixed blades, and so on, expanding slightly at each row of blades until it finally reaches the exhaust.

Thus the old Parsons steam turbine consists of two groups of fifteen successive turbine wheels, or rows of blades, on one drum or shaft within a concentric case on the right and left of the steam inlet, the moving blades or vanes being circumferential rows projecting outwardly from the shaft and nearly touching the case, and fixed or guide blades being similarly formed and projecting inwardly from the case, nearly touching the shaft.

A series of turbine wheels on one shaft is thus constituted, each one complete in itself like a parallel flow water turbine, the steam, after performing its work in each turbine, passing on to the next, preserving its longitudinal velocity without shock, gradually falling in pressure on passing through each row of blades, and gradually expanding. Each successive row of blades is slightly larger in

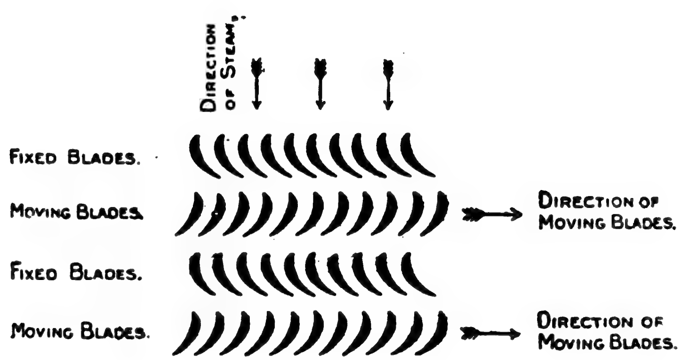
passage-way than the preceding, to allow for the increasing bulk of the elastic steam, and thus its velocity of flow is regulated so as to operate with the greatest degree of efficiency on each turbine of the series. All end pressure from the steam is balanced by the two equal series, one on each side of the inlet, and the revolving shaft lies on its bearings revolving freely without any impressed force except a steady torque urging rotation, the aggregate of the multitude of minute forces of the steam on each blade. But before this could be made a practical success it was necessary to carry out a series of experiments on shafts revolving at very high speeds, and this was done by Mr. Parsons about 1884. It is not possible to run a shaft or spindle in fixed bearings at very high speeds, as owing to the impossibility of making a shaft absolutely true, and of obtaining material of absolutely uniform density, such a shaft is always slightly out of truth and balance, and violent vibration and heating of the bearings is set up at such high speeds. This difficulty can, however, be got over by the very beautiful device of allowing a little play in the bearings to compensate for any lack of balance.

Such a bearing consists of a bush in which the spindle revolves, surrounded by three concentric tubes with a slight amount of clearance between each. The small annular spaces between the tubes are filled with a film of oil, and the whole makes a flexible bed for the shaft to run in, taking up all vibrations which in turn are damped out by the films of oil.

The steam turbine described constitutes a truly rotary engine, but it had limitations. The comparatively high speed of rotation that was necessary for so small a size of engine as this first example made it difficult to prevent a certain spring or whipping of the shaft, so that considerable clearances were found necessary, and consequently leakage and loss of efficiency resulted. It was, however, perceived that these defects would decrease as the size of the engine was increased, with a corresponding reduction of rotational velocity, and efforts were therefore made towards the construction of engines of larger size, which resulted in 1888, in several turbo-alternators of 120 horse-power being supplied for the generation of current in electric lighting stations, and in 1892, the compound steam turbine was first adapted to work in conjunction with a condenser.

The first condensing turbine was one of 150 horse-power, and at a speed of 4,800 revolutions per minute, drove an alternator of 100 kilowatts output. It was tested by Professor Ewing, and the general result of the trials was to demonstrate that the condensing steam turbine was an exceptionally economical heat engine.

FIG. 1.



With a steam pressure of 100 lbs., the steam being moderately superheated, and a vacuum of 27″ Mercury, a consumption of 27 lbs. per kilowatt hour, which is equivalent to about 16 lbs. of steam per indicated horse-power, was obtained. The result marked an era in the development of the steam turbine, and opened for it a wide field, including some of the chief applications of motive power from steam. As a result, at about this period turbine alternators of the condensing type were placed in Newcastle, Cambridge, and Scarborough Electric Supply Stations. These steam turbines were of the radial flow type, which had been reluctantly adopted in 1891 on account of the temporary loss of the patents, but on the recovery of these in 1894 the parallel flow type was reverted to with considerable improvements in design, calculated both to increase

the economy and decrease the cost of manufacture. Instead of the steam entering at the centre and expanding both ways, one set of blades was replaced by a set of dummy pistons in which a grooved piston or dummy on the spindle ran close to, but not in contact with, corresponding grooves in the cylinder, thus making a practically steam tight and yet frictionless joint. At the same time the system of blading was greatly improved, giving a more perfect form of blade with much greater mechanical strength than in the original formation.

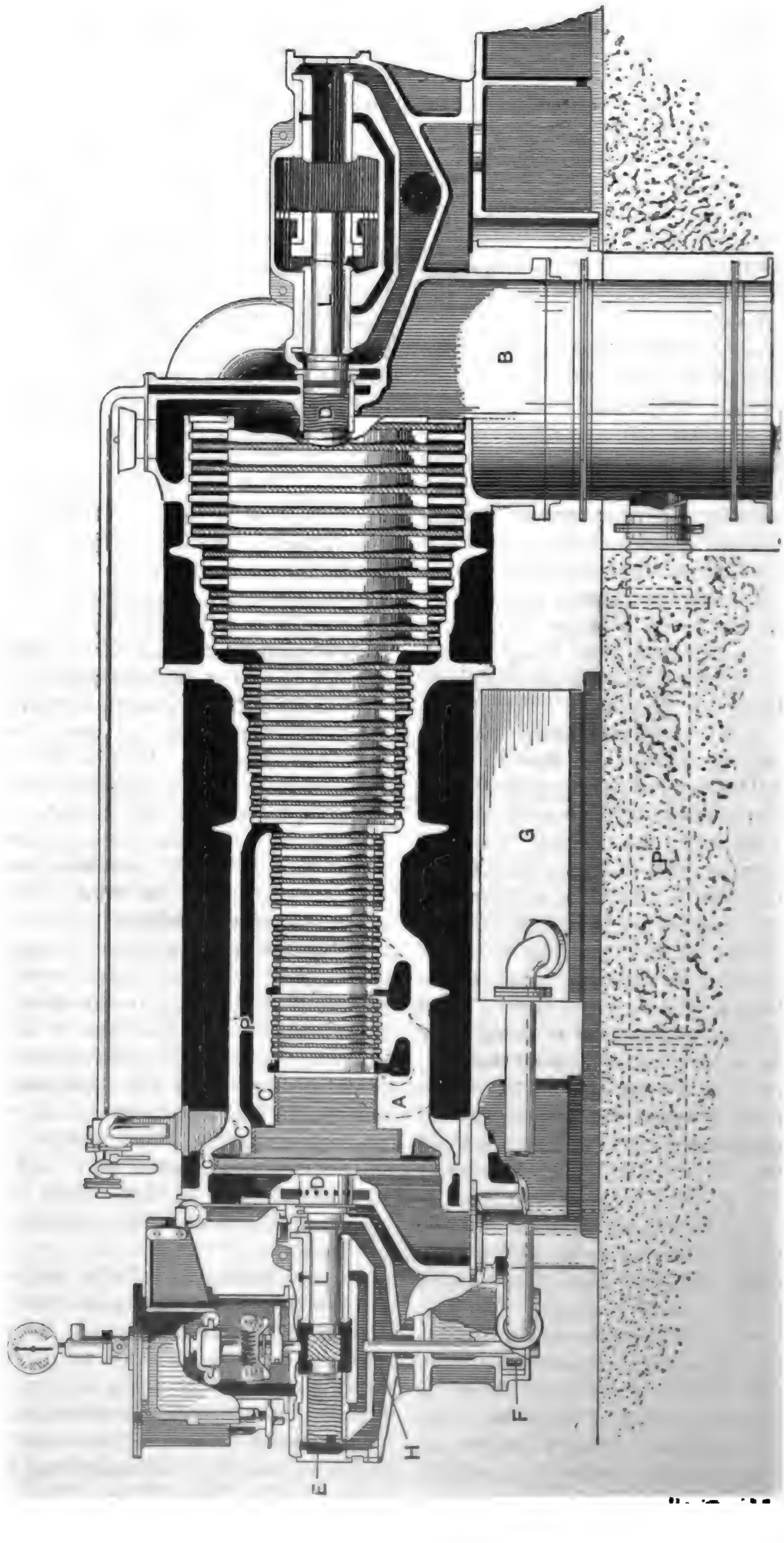
The steam turbine which is shown in section in Fig. 2 consists of a cylindrical case with rows of inwardly projecting blades. The steam enters at A on the lower half of the cylinder, thus leaving the upper half quite clear of steam pipes and all obstructions and facilitating dismantling. It then passes successively through the different rows of fixed and moving blades, as explained above, and leaves the cylinder through the exhaust pipe, B. In order to give increased passage way for the steam as it expands, the shaft is made with three steps of different diameter, the height of the blades being also increased. The steam, in addition to its rotational force, exerts a pressure endways along the shaft on the surface of the blades and the shoulders of the shaft. This is balanced by the dummy pistons, C′, C′, C‴, as shown in the section. They are made of diameter corresponding to the different parts of the turbine they balance, and are supplied with the corresponding steam pressure through the pipes, P′, P″. The shaft thus runs in complete balance endways, and can be moved backwards and forwards with a light lever, even when the turbine is running under full load. In order to prevent steam leakage, grooves are turned in these pistons, into which project, without, however, touching the moving parts, suitably shaped strips of brass caulked into grooves in the cylinder. The whole forms a labyrinthine passage offering great resistance to the escape of the steam, most of which is carried round and round by the skin friction of the dummy pistons, producing a most effective screen against leakage. The two glands, D, where the shaft leaves the turbine casing, are constructed in precisely the same manner. The steam for packing them is obtained from the exhaust of the steam relay, a live steam connection being fitted for use before starting up. An ejector is also fitted to draw excess steam away from the glands. The coupling between the turbine and generator is of the flexible claw type, to allow for slight difference in alignment of the two portions of the plant. The thrust-block, E, at the end of the turbine shaft, merely keeps it in place with the right clearance between the fixed and moving parts of the glands and dummies, and adjustment is made in a few minutes with a small liner behind the thrust-block.

The first large turbines of this improved type were of 350 kilowatts output, and were placed in the Manchester-square Station, in London, of the Metropolitan Electric Supply Company. This station was, at the time, threatened with an injunction for vibration caused by the reciprocating engines used there, and the substitution of the turbines proved entirely satisfactory, both to the users and to the Company.

In 1900, two 1,000 kilowatt turbo alternators were supplied to the City of Elberfeld in Germany, which were tested by a committee of German experts on behalf of the city, and showed a steam consumption of 18·22 lbs. per kilowatt hour at full load. This result has been surpassed in many cases, notably in the case of the 5,000 kilowatt plants for the Carville Electric Power Station, with which a consumption of 13·2 lbs. of steam per kilowatt hour was obtained. Within the last twelve years the output of the Parsons steam turbine has gone up by leaps and bounds, until there are now on land about 2,500,000 horse-power of the Parsons steam turbine at work and on order. Practically the whole of the great power distribution scheme in the North-East of England at Newcastle is supplied with these steam turbines. This not only supplies electricity for lighting to the district around Newcastle, but also the whole of the power to many works, shipyards, and factories, besides the electrification of the Tynemouth lines of the North Eastern Railway. In the power stations supplying that district there are erected—besides smaller ones—eight turbines of 5,000 kilowatts each, the latter only taking 13·2 pounds of steam per kilowatt hour at full load.

In the Rateau and Zoelly type of turbine (which have been developed chiefly on the Continent), unlike the Parsons, in which expansion takes place both in the fixed and moving blades, the whole of the expansion is in the fixed blades, the moving ones being cup-shaped so as to turn the steam and make it give up its energy without altering its velocity while passing through them. The fixed blades are in a series of diaphragms in a cylinder, with

FIG. 2.



SECTION THROUGH TURBINE.

a shaft passing through holes at their centre, which shaft carries a series of discs having cup-shaped blades on their circumference. Where the shaft passes through the diaphragms there are suitable glands so as to minimise the leakage of steam as much as possible; and, in order to get a good height of blade, the fixed or guide blades, especially at the high pressure end, only extend to a portion of the circumference. As a rule, all the discs are approximately of the same diameter, expansion of the steam being allowed for by both increasing the height of blade and also increasing the widths of the sectors of blades admitting to the revolving discs.

The Curtis turbine, which was originated in America, is of a similar construction of diaphragms, carrying sectors of fixed blades with revolving discs between, but these discs carry, instead of one row of blades, two, three, and sometimes four rows with fixed blades between, each row taking up a portion of the velocity of the steam and delivering it to the next row of guide blades at reduced velocity; and when its energy has become exhausted, it is delivered to the next diaphragm, where the drop of pressure enables it again to act on another set of moving and guide blades, and so on until the exhanst is reached.

And now as to the theoretical aspects of the question. Some sixty to seventy years ago the thermo-dynamic theory of steam was worked out by Carnot, Regnault, Clausius, Rankine, Kelvin, and others, and it was shown that under given conditions of superheat, steam pressure, and vacuum, it was not possible to get more than the amount of power out of the steam as expressed by the cycle which was worked out almost simultaneously by Rankine and Clausius. It is, then, the object of the turbine designer to obtain a result as close as possible to the result which should be obtained according to the above cycle. In this connection it is necessary to have the ratio of the steam passing through the blades the best in relation to the velocity of the blades, and experience has shown that in the Parsons type of turbine this is best when the velocity of the steam is somewhere about double the velocity of the blades, and in the Rateau a little over one-third.

Now the velocity of the steam depends on the drop in pressure between one row of blades and the next, and it can be shown that $v^2 = 2\ g\ H\ \frac{dp}{p}$ where $g =$ gravity, H is the homogeneous head of steam which is about 63,000 feet for high pressure steam and about 45,000 feet for steam at atmospheric pressure, p is the absolute pressure at any row of blades, and dp is the drop of pressure between one row of blades and the next, and therefore $\frac{dp}{p}$ is the amount of expansion that takes place in any row of blades.

Take, as an example, a Parsons turbine, as shown in Fig. 3, which is the blading diagram for a 500 kilowatts turbine for 3,000 revolutions per minute, and 150 lbs. pressure, with a vacuum of 28″. If we assume that the turbine is of the same diameter throughout, it is easily seen that since the speed of the blades is constant, in order to make the velocity ratio between the steam and the blades constant, the velocity of the steam through the blades must be constant, and as the steam at each row expands by the amount $\frac{dp}{p}$ it is evident that each row must have larger openings than the one before by the amount $\frac{dp}{p}$, and also that this ratio $\frac{dp}{p}$ is a constant throughout the turbine on the assumption that H is constant, which is approximately the case, and for a preliminary consideration may be assumed.

From the equation $v^2 = 2\ g\ H\ \frac{dp}{p}$ the velocity of the steam can be calculated at any point along the turbine, and from this and the area through the blades the quantity of steam used per hour can be calculated. In taking the area of the blades it is necessary, not only to take the actual area through the blades, but also that of the clearance space above them, and further to the quantity thus calculated there has to be added the leakage through the dummies, and also, if steam packed glands are used, the quantity of steam required to pack these glands.

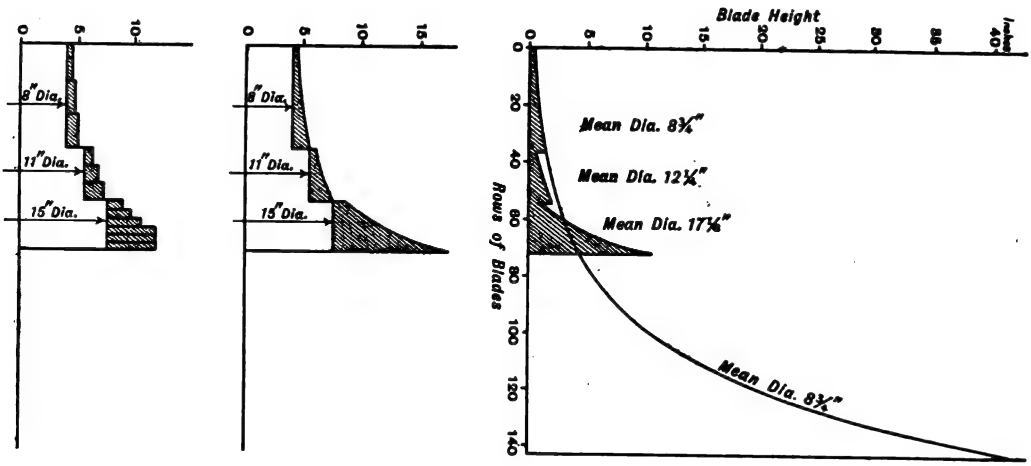
Both these items, especially the latter, are small ones, but when all these allowances are made it is found that within errors of observation the quantity of steam used by a turbine is the calculated one. It is thus easy to calculate the quantity of steam used by a turbine, but the horse-power it will produce is another question, and in many cases, especially in new types or sizes of turbine where the steam consumption per kilowatt hour was uncertain and a considerable magin was left, it was found that the steam pressures required to give the rated output were considerably lower than was anticipated.

The fact that the steam consumption of a

turbine so nearly agrees with theory proves that the velocity of steam through the blades must very closely approach the theoretical, and in fact, unless this was the case, it would be impossible to get from turbines the high efficiencies that are obtained. We therefore have a turbine consisting of a drum with blades gradually increasing in height according to what is known as a logarithmic law, that is, each row of blades is $\frac{dp}{p}$ higher than the preceding one.

Now since, in an ordinary turbine working from say 150 lbs. steam pressure down to a pressure of one pound absolute, or a vacuum of 28″, there are about 150 expansions by pressure—or, say, 100 expansions by volume—drums each $\sqrt{2}$ or 1·4 times the diameter of the other, and thus the blades on the second drum are half the height of what they would be if they had been on the diameter of the first drum, and the blades on the last drum one quarter the height of what they would have been if they had been on the diameter of the first drum. This, in the case mentioned above, where there are 100 expansions by volume, reduces the ratio of blade heights from 100 to 25, and by making the blades at the exhaust end of larger opening, so that they have double the capacity for steam of the ordinary blades, the ratio of blade heights is further reduced down to 12½, and this is a very common ratio between the blades at the high pressure and

Fig. 3.



we require the blades at the low pressure end 100 times as long as the high pressure end, so that it will easily be seen that the blades at the low pressure end would be so long as to be impossible to put on the spindle. The device, therefore is adopted of increasing the diameter towards the low pressure end (see Fig. 3), and, since an increase of diameter also increases not only the circumference but also the velocity of the blades, it is easily seen that the height of blade will vary inversely as the square of the diameter: that is, if you double the diameter, you double the velocity of the blades, therefore you double the velocity of the steam, so that you require only half the area through the blades, but since the circumference is doubled you only require blades of one quarter the height. The usual custom in land turbines is to have three the blades at the low pressure end in ordinary land turbines.

The three drums of the turbine are so proportioned that about a quarter of the power is in the first, a quarter is in the second, and half in the third, but this is purely an arbitrary division, and can be varied within wide limits to any extent desired, but in practice it comes out as a very fair compromise between the various conflicting conditions that have to be considered. Small diameters are an advantage, because you get longer blades, but, on the other hand, as we have shown before, the height of the blade varies inversely as the square of the diameter, and it must be further remembered that the number of rows required for a definite expansion also varies inversely as the square of the diameter, and therefore with small diameters you get great length of

drum and long blades, and with larger diameters you get short drums and short blades. The first gives you a turbine shaft of great length which is liable to bend and whip, and therefore the clearance over the tops of the blades has to be increased: the latter gives you very short blades, and on account of their shortness the percentage loss by leakage over the top of the blades is large, and the best result is obtained by a happy compromise between the various conflicting conditions. In this relation it is easily seen that for any given number of expansions and revolutions to obtain a given velocity ratio, a certain volume of spindle is necessary, or generally a more convenient way of expressing it is that the product of the number of rows multiplied by the square of the blade velocity gives a constant which, for any given number of expansions gives a certain velocity ratio between the blades and the steam, which may be from 0·4 to 0·6.

The above theory is on the assumption that H is constant, that is, that steam is a perfect gas, which, of course, is not quite true, and therefore, in order to attain accuracy, corrections have to be made for the difference between steam and a perfect gas, but these being of a secondary order, they are as a rule most easily made by considering H to be constant for various portions of a turbine separately.

In the above turbine, as I have shown, the theoretical curve for the blades is a logarithmic one, but it is almost impossible in practice to make a spindle and cylinder of logarithmic curves, and therefore the device is adopted of stepping the turbine, and, as shown in Figs. 2 and 3, it will be seen that the blades are stepped so as to approximate closely to a logarithmic curve, each step being made so small that there is no appreciable loss of efficiency due to the varying velocity ratios along the step. Another method of calculating turbines is by the entropy diagram or $\theta\ \varphi$ method, and this leads to exactly the same results as the method using H, or the homogeneous head of steam, which is given above. Some designers prefer one method, and some the other, but personally I have always preferred what may be called the H method.

Other types of turbines such as the Zoelly, Rateau, and Curtis, can be calculated in the same way, but the velocity ratios to give the best results are different for them, and each type of turbine has to be considered separately on its own merits. In turbines, it is easily seen that, for a given size, the lower limit of speed is one in which the blades become so short as to cause excessive leakage, and thus loss of efficiency. On the other hand, the upper limit of speed is one in which it is impossible to get sufficient area through the low pressure blades to give good results, since it is not allowable to stress the drum or disc to which the blades are fastened beyond a certain point, and therefore the surface speed is fixed, and it is also necessary not to stress the blades beyond a certain point, and therefore the maximum height of the blade on the drum or disc is also fixed.

Another thing is that it is found not to be advisable to have the height of blades more than one-fifth to one quarter of the diameter of the drum to which they are fixed, as otherwise they spread so much at the tips as to become a bad shape.

With these limitations, it can be shown that turbines can be constructed of similar dimensions to run at speeds the inverse of those dimensions. Thus, if we take a 1,000 kilowatt turbine, running at 3,000 revolutions per minute, and double the size of it all over, the surface speeds will be the same at 1,500 revolutions per minute, and the stresses on the material of the blades, drum, &c., will be the same. On the other hand, we have double the diameter and double the height of blade, and therefore four times the area for the steam to pass through, with the blades moving at the same velocity, and, as a result, four times the power will be obtained, or our turbine at 1,500 revolutions will give an output of 4,000 kilowatts. This gives the limiting speed for any given turbine, but except in exhaust turbines, which work with steam at atmospheric pressure, and therefore have to deal with great volumes, and also turbine-driven blowers which run at an average of about one and a-half times the speed of turbines driving alternators and dynamos for similar outputs, this limit is rarely attained.

Now it can be shewn that alternators also obey the same rule of varying inversely as the square of the speed, and thus it will be seen that alternators coupled to turbines go up in size together, and that apart from the trouble there is due to being compelled to have an even number of poles, alternators of the maximum size for that speed have similar turbines attached to them. For instance, as above, a 1,000 kilowatt turbine attached to a 1,000 kilowatt alternator at 3,000 revolutions per minute will have similar properties and characteristics

to that of a 4,000 kilowatt turbine attached to a 4,000 kilowatt alternator at 1,500 revolutions per minute, and thus there is no limit to the size of turbo-alternator. In the case, however, of continuous current dynamos, the output of a dynamo (as it is chiefly limited by commutation conditions which depend principally on the ampere turns on the armature per inch diameter) is practically only proportional to the speed, and it is easily seen that a limit is soon reached where the speed of the turbine is too low for economical conditions.

This statement that the output of a dynamo varies inversely as the speed is not exactly true, the real ratio in practice being as the 1½ power of the speed, but still soon a limit is reached for continuous current work, and although we can make a 1,000 kilowatt alternator running at 3,000 revolutions per minute we can only make a 500 kilowatt continuous current dynamo to run at the same speed, or a 1,200 kilowatt to run at 1,500 revolutions per minute. The 500 kilowatts at 3,000 revolutions per minute is a very good machine, and so is the latter, but this is about the lowest speed at which a turbine can economically run at that size, and thus no-one has put more than about 1,200 or 1,500 kilowatts into one dynamo. However, by using tandem dynamos it will be seen that the output is doubled, and this enables tandem turbo-dynamos up to about 4,000 kilowatts to be economically built.

In the design of marine turbines the same lines are followed exactly as in the design of land turbines, but in marine turbines the limitations of the screw propeller are to be dealt with instead of the limitations of dynamos, alternators, &c., in land work, and the importance of carefully balancing the efficiency of the propeller against the efficiency of the turbine has to be most fully considered. Screw propellers, as a rule, are more efficient the slower they go, turbines are less efficient the slower they go, and therefore the balance between the two has to be most carfully looked into. As a result it has been found that with simple installations of screw propellers and turbines it is not advisable to go in speed below 15 to 18 knots. This will be easily understood if we take, for example, the express Cunarders *Lusitania* and *Mauretania*, and compare them with the *Carmania*. The engines of both run about the same speed, viz., about 180 revolutions per minute, and yet for 25 knots in the *Mauretania* there is a power of about 65,000 horse-power, and for 18 knots in the *Carmania* there is only about 20,000 horse-power. It is thus seen that, on account of the limitations of the screw propellers, while the turbines on the *Lusitania* and *Mauretania* are working under the best conditions possible, the turbines of the *Carmania* are not working under nearly so good conditions, and it was only on account of her very careful designing that the *Carmania* has proved to be the success she is.

This subject will be further dealt with in my last lecture.

HOME INDUSTRIES.

Unemployment.—The question of unemployment is becoming acute again. The state of the labour market is serious and the outlook discouraging. During the first five days in which the Registers of the Metropolitan Distress Committee were opened the number of applicants was 7,800, a higher total than for the corresponding period of last year. It must be remembered that the habit of applying for assistance strengthens with each year's distribution of relief work. A man who applied last year is more likely to apply this than if he had never applied; but with due allowance made for this fact the applications have increased. At the first meeting of the Central (Unemployed) Body for London, held last week, a resolution was unanimously passed declaring that "in the experience of the Central Body the Unemployed Workmen's Act of 1905 has proved quite inadequate to deal with the constantly recurring distress from unemployment." But it is fair to the authors of that Act to remember that it was passed as an experiment for three years only. The main object of the Act was the direct assistance of the unemployed by the old method of temporary relief work. It aimed at providing a temporary refuge for a comparatively few men, and it was not intended that it should be used by men not competent and industrious. Temporary assistance by relief work was to be provided only in times of exceptional trade depression. The administration of the Act on this side was made dependent upon the raising of voluntary subscriptions. During the first year the Act was financed in this way. A public appeal on behalf of the unemployed made by the Queen resulted in the subscription of over £150,000, of which nearly £125,000 was distributed to the authorities established under the Unemployed Workmen's Act. But an appeal of this kind could not be repeated, and in 1906 Parliament put £200,000 at the disposal of the Local Government Board to supplement voluntary contributions, and this precedent was followed in 1907 and 1908. It may be doubted whether the class of persons relieved under the Act was the one intended, namely, men honestly desirous of obtaining work, but temporarily unable to do so from exceptional causes. The bulk of those relieved have been labourers or irregular workmen, with whom want of employment was not exceptional. The temporary

assistance under the Act was to be made unattractive by the rule that the "total remuneration . . . . . for any given period of continuous work should be less than that which would under ordinary circumstances be earned by an unskilled labourer for continuous work;" but the Poor-law principle, that assistance should be less attractive than independence, has not been observed. The difficulties experienced in the working of the Act throw doubts upon the practicability under present conditions of any form of public assistance outside the Poor-law. The Unemployed Workmen's Act, to quote Mr. Beveridge's review of it ("Unemployment," page 191) has done a good deal in the way of collecting information. It has done a little to co-ordinate existing agencies, and improve in minor points the administration of special relief. It has not made any appreciable impression upon the problem. Its main service has been to demonstrate the inadequacy of all measures which, like itself, leave industrial disorganisation untouched, and deal only with the resultant human suffering.

The Government and Wireless Telegraphy.—The official announcement of an agreement between the Post Office and the Marconi Company by which the former acquires for £15,000 all the Marconi coast stations communicating with ships, the surrender of all rights held under agreement with the Post Office, and liberty to use free of royalties all existing and future Marconi patents for the next 14 years for ship to shore communications, has been received with much satisfaction. From the strategic as from the commercial point of view the arrangement is of obvious value. In making his statement to the House of Commons the Postmaster-General said that the negotiations and arrangements have been conducted with the knowledge of, and in consultation with the Admiralty, who have long desired that the coast wireless stations should be in the hands of the Post Office. And from the commercial standpoint the arrangement is welcomed. It is in no sense an exclusive one. All the stations will, under the International Radio-Telegraphic Convention, be open for communication equally to all ships whatever system of wireless telegraphy they may carry, and the Post Office will be free to use or experiment with any system of wireless telegraphy that may commend itself. The Postmaster-General was able to add that arrangements have also been made with Lloyds for the transfer to the Post Office of their wireless stations for communications with ships, and for the surrender of all claims to licenses for such communication. In return Lloyds will receive the plant value of their stations, and will have transmitted to them (with due regard to the secrecy of private telegrams) information received at the Post Office stations with regard to the position and movement of ships, and other maritime intelligence. The agreement by which Lloyds bound themselves to use only the Marconi system—an agreement always regretted by Lloyds—is cancelled, and the net result of these arrangements is that the State acquires all the wireless stations engaged in commercial work in this country, except the long distance stations, and the possibility of a private company and a single system securing a monopoly is disposed of. That these many advantages should have been secured by the Government for £15,000 is remarkable.

Shipbuilding.—The high price, comparatively, of steel, and the speculative position of pig iron, make shipbuilders a little shy of booking new orders on the basis of the present prices of material, while shipowners are not likely to buy more new ships if prices are advanced. But the record of the Scotch shipbuilding yards for September shows improvement upon that of the preceding month, the output being about 2,500 tons more than for August. The Clyde production of September was about 46,000 tons, a large part of it—32,000 tons—being of the tramp order. A large proportion of the new work is on war ships. There are now building on the Clyde one battleship, two cruisers, and twenty torpedo boat destroyers, in addition to a cruiser just launched. The new contracts of September are estimated at about 45,000 tons, and it is understood that more contracts have been booked than have been reported. Many of the Clyde shipbuilders are said to have work in hand that will keep them well employed on to the spring.

Asylum Workers' Pensions.—Sir William Collins' Asylum Workers Superannuation Bill has now reached the Lords, and as in 1898 they passed through all its stages a Bill granting pensions to all asylum workers without the contributory basis—which is the basis of the present Bill—it may be assumed that the Peers will agree to it. Sir William Collins' Bill gives assured pensions to workers in asylums, whereas the present law only gives optional power to the authorities to grant such pensions under the Act of 1890. The Home Office and the Lunacy Commissioners are in favour of the Bill, and it is well backed throughout the kingdom.

Sea Fisheries.—A conference has been arranged by the National Sea Fisheries Protection Association to be held at the Town Hall, Great Yarmouth, on the 19th and 20th of this month. The list of subjects to be discussed is a large one, and includes "Fish diet for the Navy and Army," "Rewards for evidence to convict trawlers," and "The compulsory granting of certificates to captains of steam fishing-vessels."

Lighting-up Factories.—A safe method of lighting-up in factories and other industrial premises where gas is used has long been wanted. Electric torches are used, but it is found to be difficult to keep them in perfect working order at all times. The safety lamp invented by Messrs. Hall and Kay is used largely in cotton mills, but there is a difficulty with incandescent gas where the burners are of the inverted

type, and the mantles enclosed in globes. A new torch has just been put upon the market which is said to prove equally effective with all kinds of burners. It consists of a slender metal cylinder containing a lamp, burning colza oil. Pressing a button raises the lamp within the cylinder until the flame is projected against a protecting shield constructed of wire mesh over the top of the cylinder. Three small arms tipped with rubber, and projecting laterally from the top of the cylinder, protect the incandescent mantle from injury through impact of the torch against any part of the gas fittings.

CORRESPONDENCE.

BURIED TOADS.

In confirmation of Sir James Monteath's story, I send you the following account of a toad which was discovered in a plum tree when it was cut down. It was in Jersey in 1856. The creature looked dead; the tree had grown round it and shewed no sign of crevice, or rent. It was not a large tree but very picturesque in contortion of branches, and had left off bearing fruit and gradually withered. The old gardener decided to cut it down and plant a new one. When he began to cut the trunk into sections he discovered the toad and split the tree in two to liberate it. The wood was simple rotten fibre, very white, and had evidently grown round the live creature, for when it came out of its hole, a perfect mould was left of it, even the strange flat feet defined as if it had been a plaster of Paris mould. Of course we thought it was dead and so buried it, but for fear it should come to life again poured boiling water on it. After about half-an-hour it showed signs of life. In about three days it began to swell out and get moist and hide under the big leaves in the garden; in a month it was difficult to distinguish it from other toads, and it was very lively. After six months we left the place, and I do not know how long it lived. The piece of tree was given to the museum by Col. Turner, who said he thought the tree was about 30 years old, and the toad must have been in it some 25 years, a mere minute compared with his Indian brethren.

M. ADLINGTON.

[Toads about to hibernate crawl into holes, and this fact is believed to account for the numerous stories of their being found embedded in rock or in tree trunks. There is no doubt that a frog or a toad can live for a considerable time—several months —with little or no food, so long as he is kept damp. Put him in a dry place and he shrivels up at once. The reason for this is that his skin is richly provided with blood vessels, and acts as an efficient respiratory organ; but the exchange of gases, which is the essential part of respiration, cannot be carried on save with a moist membrane. A frog in an ordinary sitting-room would die in a few hours of asphyxia. Frank Buckland, in his "Curiosities of Natural History" (published in 1857), records some experiments made by his father, Dean Buckland, to test the possibility of toads living enclosed in cavities. From these experiments it appears that toads, sealed up in small chambers of porous stone, to which air and water could percolate, and to which possibly small insects might have had access, in a few cases survived as long as two years. Toads placed in holes in trees with the openings plugged up were all found to be dead and decayed at the end of a year. Dr. Buckland was never able to find trustworthy evidence for any of the numerous stories of toads having been found in cavities of rocks or trees where they had been entombed for any great length of time. His record story was one of a frog disinterred from a block of coal freshly hewn in a coal mine. The newspaper reporter comments on the animal having been a contemporary of Noah, or even of Adam, but here he would seem to have done scant justice to the longevity of his frog, since neither of these patriarchs can conceivably have lived in the carboniferous epoch.—ED.]

OBITUARY.

SIR JOHN HENRY JOHNSON.—Sir John Henry Johnson, who died at his house near Clacton-on-Sea on the 2nd inst., was a life member of the Society since 1890. He was for many years an active member of the Court of the Drapers' Company, and was one of those who were associated with the movement which resulted in the establishment of the City and Guilds of London Institute. When the Drapers' Company dissociated themselves from the Institute, and devoted their funds, and their attention, to the development of the East London College at the People's Palace in Mile-end-road, Sir John Johnson took a great deal of interest in the work, and became Chairman and Treasurer of the College. He was twice Master of the Drapers' Company.

THEODORE MINOT CLARK.—An intimation has been received of the death at Boston, on April 30th, of Mr. Theodore Minot Clark. Mr. Clark was born in Boston in 1845, and educated at Harvard, whence he graduated in 1866. Having selected architecture as his profession, he came into prominence by his plans for a series of great docks in South Boston, and he was also the prime mover in the establishment of a day camp for consumptives on Parker Hill, the buildings of which were designed by him. He was the author of many well-known books on architectural subjects, notable among which are "Rural School Architecture," "Care of a House," and "Building Superintendence." He joined the Royal Society of Arts in 1903; he was also a Fellow of the American Institute of Architects and a member of the International Institute of Public Art at Brussels.

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FRIDAY, OCTOBER 15, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

VIVA VOCE EXAMINATIONS IN MODERN LANGUAGES.

During the present year 27 examinations have been held in London, Manchester, Bristol, Hitchin and Guernsey.

At these examinations 656 candidates presented themselves, of whom 506 passed (166 with distinction) and 150 failed. The languages taken up were French, German, Spanish and Italian.

The results of previous years are as follows:—

Year.	Number Examined.	Passed.	Failed.
1902	280	202	78
1903	456	324	132
1904	540	375	165
1905	681	502	179
1906	644	469	175
1907	629	476	153
1908	615	467	148

The following is a complete list of the *Vivâ Voce* Examinations held during 1909:—

Place of Examination.	Date.	Number of Candidates.	Passed with Distinction.	Passed.	Failed.
French:—					
Hitchin	March 22.	20	1	11	8
Regent-street Polytechnic (Candidates from London Polytechnics)	May 18.	24	4	15	5
City of London College (Candidates from London Polytechnics)	May 19.	33	8	20	5
Manchester Education Committee	May 20.	18	6	6	6
Kensington College	May 25.	28	14	9	5
Willesden Polytechnic	May 26.	23	7	11	5
Enfield Technical School	May 27.	25	7	15	3
Pitman's Metropolitan School (Candidates from London Polytechnics)	May 28.	32	11	16	5
French (continued):—					
Acton and Chiswick Polytechnic	June 2.	23	1	17	5
Guernsey Education Committee	June 8.	24	10	14	—
"Barnsbury Park" L.C.C. School	June 30.	27	18	8	1
"Barnsbury Park" L.C.C. School	July 1.	30	5	22	3
L.C.C. Evening School, Sussex-road, Brixton	July 2.	27	7	16	4
L.C.C. Evening School, William-street, Hammersmith	July 5.	23	10	10	3
L.C.C. Evening School, Plough-road, Clapham Junction	July 6.	22	6	6	10
"Oliver Goldsmith" L. C. C. Evening School, Peckham-road	July 7.	29	5	19	5
Merchant Venturers' Technical College, Bristol	July 8 & 9.	64	9	35	20
German:—					
Manchester Education Committee	May 17.	6	3	2	1
Regent-street Polytechnic) Candidates from London Polytechnics)	May 21.	28	9	11	8
City of London College (Candidates from London Polytechnics)	May 24.	24	7	10	7
Pitman's Metropolitan School (Candidates from London Polytechnics)	May 25.	20	3	12	5
L.C.C. Evening School, Queen's-road, Dalston	June 28.	15	3	7	5
L.C.C. Evening School, Kennington-road	June 29.	20	6	9	5
Merchant Venturers' Technical College, Bristol	July 7.	33	1	19	13
Spanish:—					
Manchester Education Committee	May 18.	5	—	3	2
City of London College (Candidates from London Polytechnics)	May 20.	20	1	9	10
Italian:—					
South-Western Polytechnic, Chelsea (Candidates from London Polytechnics)	May 28.	13	4	8	1
		656	166	340	150

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

STEAM TURBINES.

By Gerald Stoney,
B.E., M.Inst.C.E., M.I.E.E.

Lecture II.—Delivered March 29th, 1909.

In my last lecture a short account of steam turbines in general was given; in this one are described various applications of the steam turbine and some things which have conduced to its efficiency.

The design of condensers has been especially influenced by the introduction of steam turbines. As has been shown, in the old days of reciprocating engines, the condenser giving 25″ vacuum was quite good enough, but now-a-days, on account of the great improvement in economy of steam turbines, with higher vacua, it is common to have between 28″ and 29″. As a rule in the case of a condensing plant the temperature of the cooling water is fixed, and therefore, in order to obtain as low a temperature of the outlet water from the condenser as possible as large a quantity of cooling water as is practicable should be used. This again is limited by the power required to pump the water, and also by other considerations, especially where cooling towers are used, but as a fair average it is generally found that somewhere between 50 and 70 times the steam condensed can be obtained. This means a rise in temperature of the cooling water of about 17° Fahr., as it takes on an average about 1,000 B.T.U. to condense one pound of steam. This figure is rather lower than the one for dry steam, but it must be remembered that exhaust steam is nearly always wet, and therefore takes rather less B.T.U., and we have found in practice that 1,000 B.T.U. per pound of steam is a very fair figure to take.

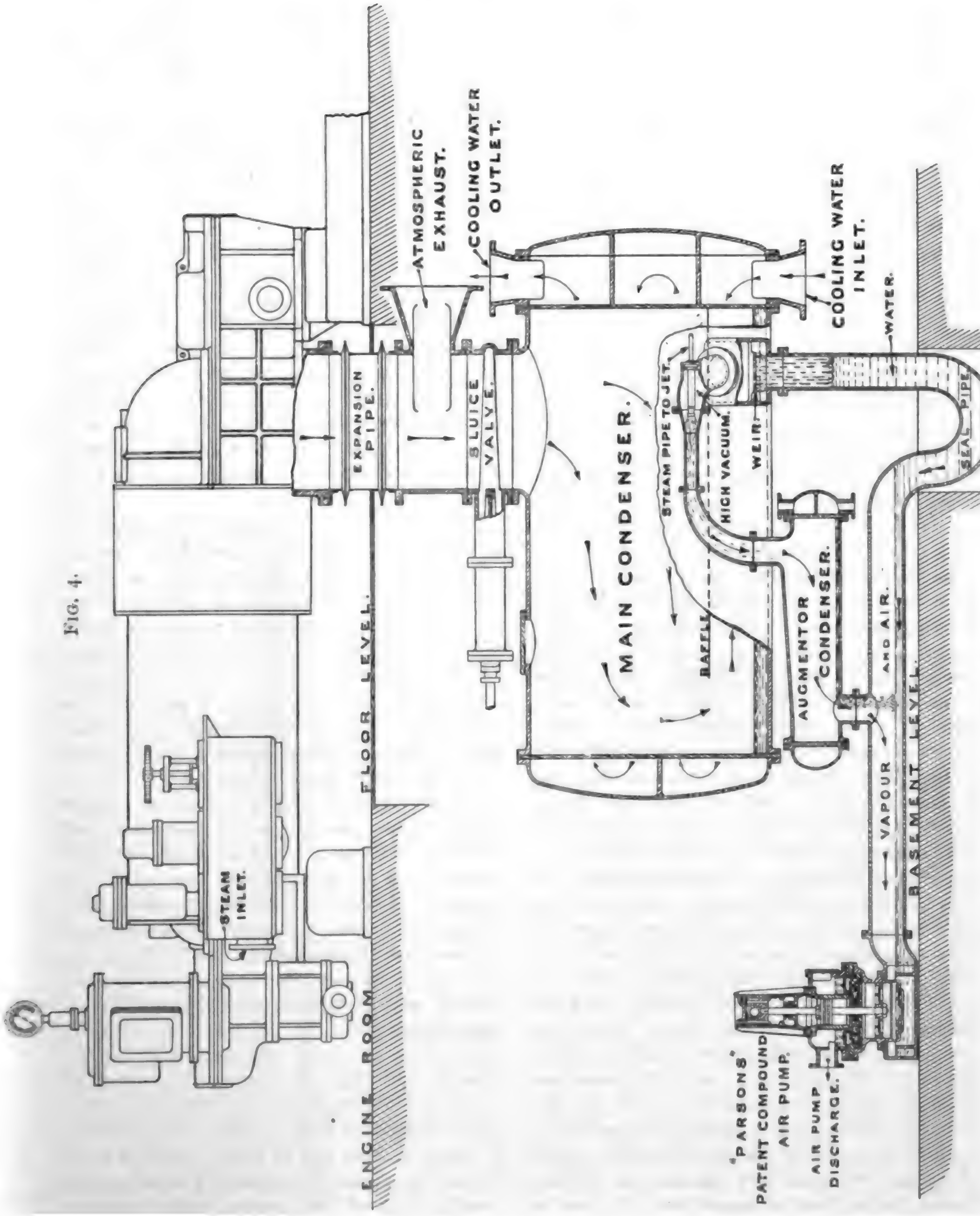
The maximum vacuum which can be obtained from a condenser is the vacuum due to the temperature of the outlet water, and the closer to this we can get the vacuum actually obtained the better. There are two ways of expressing this difference: one is in inches of mercury, and the other is in temperature, and for condenser work the latter is the more convenient. When it is remembered that from about 24″ to 27″, each inch of vacuum makes 4 per cent. difference in the steam consumption of a turbine, between 27″ and 28″ about 5 per cent., and from 28″ to 29″ six or seven per cent., or that approximately 3° Fahr. difference in the temperature of the exhaust, means an increase or decrease of about 1 per cent., it is easily understood how important it is to keep the difference of temperature between the outlet water from the condenser, and the temperature due to the vacuum as small as possible. This difference in good modern condensers, when condensing, say 12 lbs. per square foot per hour, can be kept as low as 5° or 6° Fahr.

Another way of looking at the efficiency of the condenser is the B.T.U. transmitted per square foot of cooling surface per hour per 1° Fahr. difference of temperature, and this figure can in well constructed condensers be as high as 1,000 to 1,200 B.T.U. The resistance to the heat passing from the steam to the water may be considered in three stages. There is first the heat transmitted from the steam to the tubes of the condenser, and this resistance is affected by the quantity of air in the condenser, and the efficiency of the air pump. With suitable arrangements, however, this resistance can be reduced to a very small figure, especially if appliances are used such as dry air pumps, or, still better, Mr. Parsons' vacuum augmentor, to withdraw the air completely from the condenser. If air is present it not only vitiates the vacuum, but also reduces the rate of condensation of the steam by, so to speak, causing a blanket of air to form round the tubes, and thus preventing fresh steam getting to them. The second resistance to the transmission of heat is in the metal of the tube itself, but this, with metal tubes, such as are always used, is an exceedingly small figure, and may be neglected. The third and last is the resistance to the passage of heat between the metal of the tubes and the cooling water, and this is apparently one of the principal losses, and varies enormously with the cleanliness of the tube. If there is any slime or dirt or deposit on the inside of the tube it is found that conduction of heat very rapidly goes down, and therefore to get the best results the tubes must be kept clean. In this connection also it is necessary to have sufficient velocity of flow of the water to make turbulent flow in the tubes and not stream line flow, that is, a velocity sufficient to make the water mix up as it is travelling along the tubes and not to have a cold core of water with a hot envelope outside it next the tubes.

It is in connection with the extracting of air thoroughly from the condenser that the greatest

improvements have been made of late years, and amongst these dry air pumps, and the vacuum augmentor mentioned above and denser to the air pump, and thus, although the air pump may only produce a vacuum of, say, 27″ or 28″ there may be a vacuum of 28″ to

Fig. 4.



Diagrammatic Arrangement of Vacuum Augmentor.

shown in Fig. 4, are especially prominent. This latter consists simply of a jet of steam drawing the air and vapour from the condenser and delivering it through a small auxiliary condenser to the air pump ... 29″ in the condenser, and in practice this appliance has been found most satisfactory. The effect of using this vacuum augmentor has been in some cases to bring up the conductivity

from about 250 or 300 to between 800 and 1,000, or to reduce the loss of temperature from some 26° Fahr. to 5° Fahr., a gain in temperature of, say, 21° Fahr., or 7 per cent. in the consumption of the turbine.

When it is remembered that the steam jet of the vacuum augmentor only uses about 0·6 per cent. of the steam used by the turbine it is easily seen that the gain due to the better vacuum is vastly more than the loss due to the steam jet. This vacuum augmentor is applicable not only to surface condensers, but also to jet condensers with most beneficial results.

One great field for turbines which has only within the last couple of years come into prominence, although it was patented by Mr. Parsons some years ago, is the use of exhaust turbines, that is, turbines taking steam at atmospheric pressure from reciprocating engines or other machinery, and utilising the power contained in it in an exhaust turbine. When it is remembered that there is as much power in steam working from atmospheric pressure down to a 27″ vacuum, as between 150 lbs. down to atmospheric pressure, it is easily seen that the power of an existing non-condensing plant can be more than doubled by the simple application of an exhaust steam turbine and condenser. In cases where cooling water is not available, cooling towers can be fitted, and, of late years, these have been improved so much as to be most efficient pieces of apparatus. Also, in some cases, a further advantage has been obtained in that if the supply of water for feeding the boilers is bad, this bad water can be used in the cooling towers, where it does no harm, and pure condensed water from the turbines can be supplied to the boilers. Such installations are now in use all over the country, and from being absolutely a waste product, exhaust steam has become a most valuable by-product in many works, the exhaust steam being collected, made to drive turbines and dynamos, and the power either used in the works where the exhaust steam is produced or supplied to other consumers of electricity. In many cases the exhaust steam is intermittent, such as the exhaust steam from a winding engine of a colliery where each time the cage goes up or down there is steam from the winding engine, but in the intervals between the winds, there is none. Such intervals, if not too long, can be bridged over by a thermal accumulator. The principle of thermal storage is itself a comparatively old idea in connection with steam boilers, having been proposed by Druitt Halpin in 1891-92, but the best known form of accumulator for use in connection with exhaust steam turbines is that of Professor Rateau, where a tank containing water has the exhaust steam blown through it so that alternately the exhaust steam is partly condensed, and the water in the tank boils, and thus the supply given to the turbine is constant.

In many cases, however, the stops are too long to be bridged over by any form of thermal accumulator, and in such cases what are called "mixed pressure" turbines have been introduced in which there is a high pressure part revolving idly when exhaust steam is used, but when the exhaust steam supply fails, by an automatic arrangement this high pressure part is supplied with live steam, and thus the turbine continues to be driven. This, also, can be used in conjunction with a thermal accumulator, in such cases as a winding engine, where there are short stops only for a portion of the day, but where there are long stops at week-ends or at times when winding is not going on.

This arrangement of turbine to be able to utilize economically either exhaust steam or high pressure steam has probably a great future before it, and it is one of the remarkable things about a turbine that it has so much flexibility that such an arrangement is possible —in fact, it has been found that such mixed pressure turbines are within 5 per cent. as economical as either a pure turbine for using high pressure steam alone or a pure turbine for using exhaust steam alone.

The first applications of the steam turbine to driving machinery were in the driving of electrical machinery, and on land this still continues to be the greatest use for steam turbines. Twenty-five years ago, when Mr. Parsons made his first high speed dynamo, the usual speed of revolution was for dynamos, as a rule, from 1,000 to 1,500 revolutions per minute, and they were generally belt-driven from the engine.

Mr. Parsons made his first high speed dynamo (see Fig. 5) to run at a speed of 18,000 revolutions per minute, and it was for a power of about 10 horse-power. This increase of speed to from ten to fifteen times that of ordinary dynamos necessitated a most careful consideration of the design, both from the electrical point of view and also to meet the enormous centrifugal forces which would be engendered. These latter were met by a drum armature with spiral end winding, the whole held together by binding wire, and

the construction of the commutator segments in short lengths, dovetailed into steel rings with asbestos insulation. The diameter also was kept small, and the core and commutator were relatively of considerable length. In all turbo-dynamos the core lengths are large and the diameter comparatively small, in order to prevent stresses due to the centrifugal force being excessive.

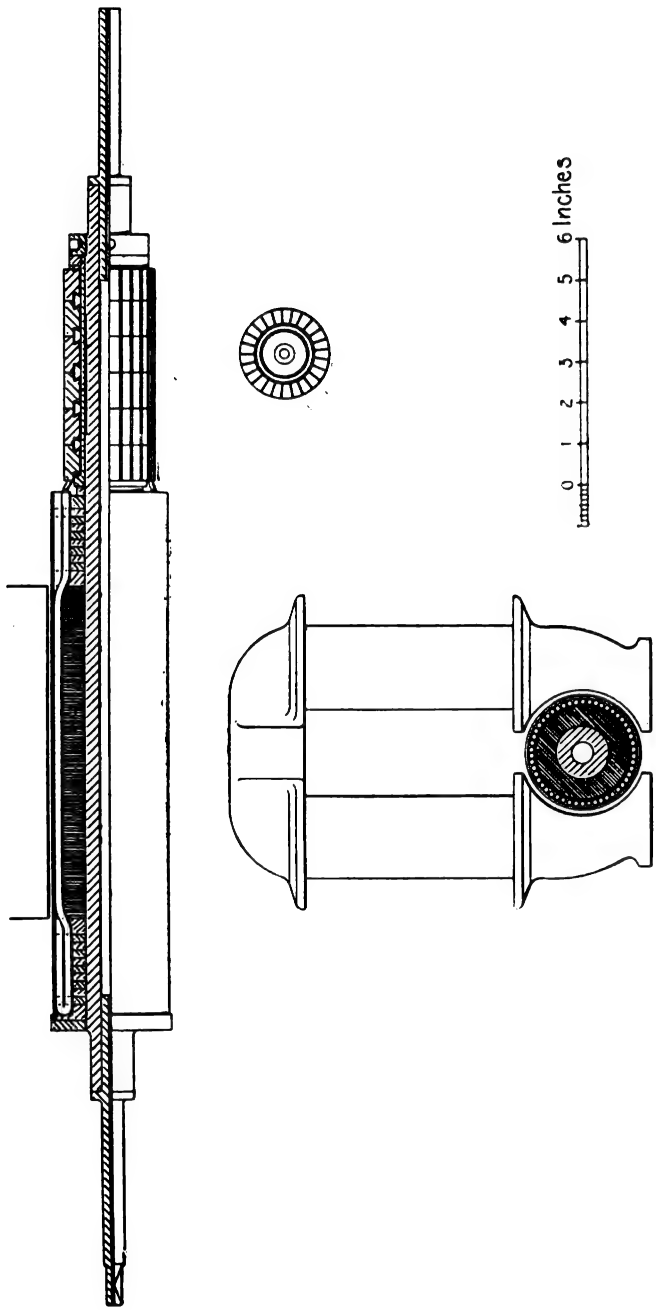


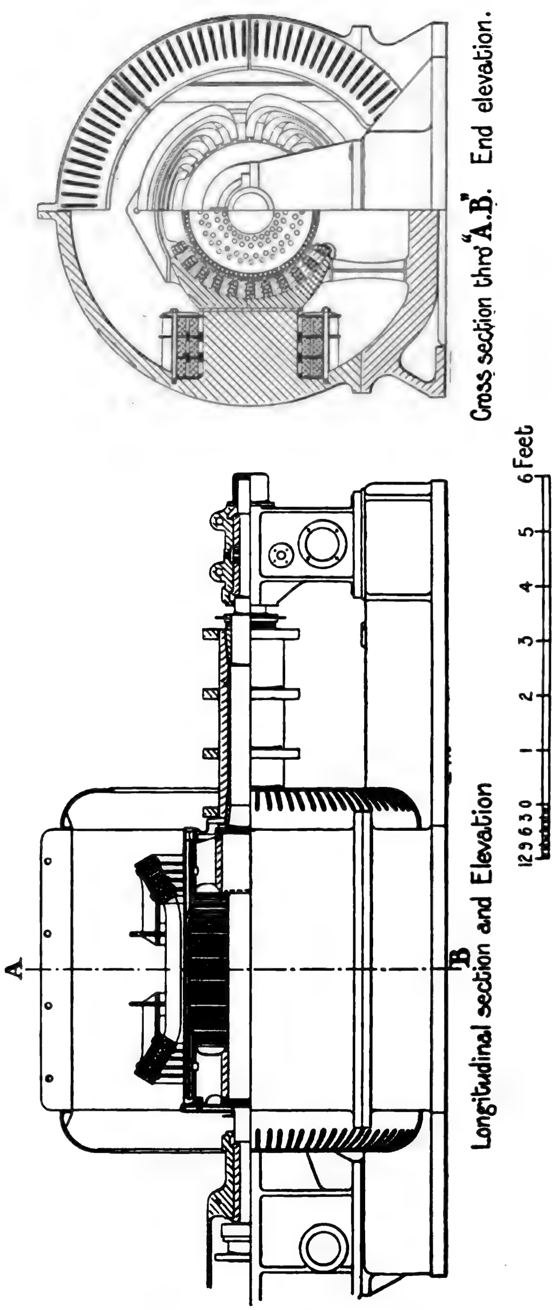
FIG. 5.

OLD TYPE CONTINUOUS-CURRENT ARMATURE.

Some of the difficulties to be met with in turbo dynamos will be understood if we compare a slow speed two-pole dynamo of 50 kilowatts for 300 revolutions per minute, with a turbo dynamo of 500 kilowatts, at 3,000 revo-

lutions per minute, also two-pole. Here we have ten times the speed of revolution, ten times the surface speed, and 100 times the centrifugal force to contend with. The output in kilowatts is proportional to the speed, or ten times, but as the former was for 110 volts, and the latter for 550, we had to have only half the number of segments, so that the voltage per segment is ten times. The frequency of the commutation is five times as great therefore, and the re-actance voltage on which the sparking largely depends is fifty times as great; and finally the hysteresis and eddy loss in the armature core will be somewhere about sixteen times as much.

FIG. 6.

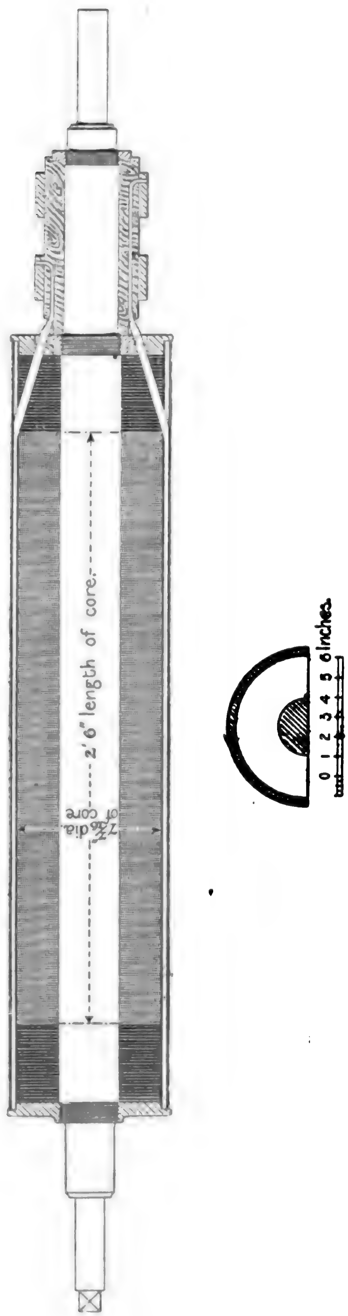


0-K.W. TURBO-GENERATOR, 480 TO 560 VOLTS, 1,800 REVS.

It is thus seen that special arrangements

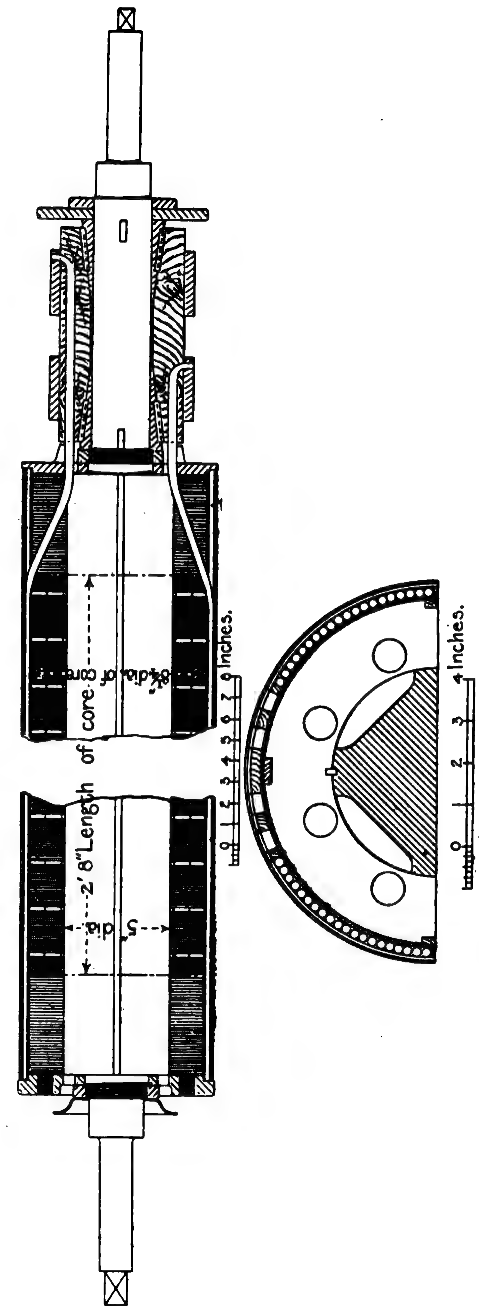
will have to be made to meet the very special conditions of a turbo dynamo. The core loss has to be taken care of by very special ventilating arrangements to enable the heat to be carried off; and centrifugal force is met by employing the best materials and most careful construction. The voltage per segment in the commutator and the re-actance voltage, the two principal things which govern commutation, are met with by the provision of either commutating poles or compensating winding, or a combination of the two. In our experience we have found compensating winding alone most satisfactory, and the adoption of such

Fig. 7.



75-K.W Single-phase Turbo-Alternator Armature.

Fig. 8.

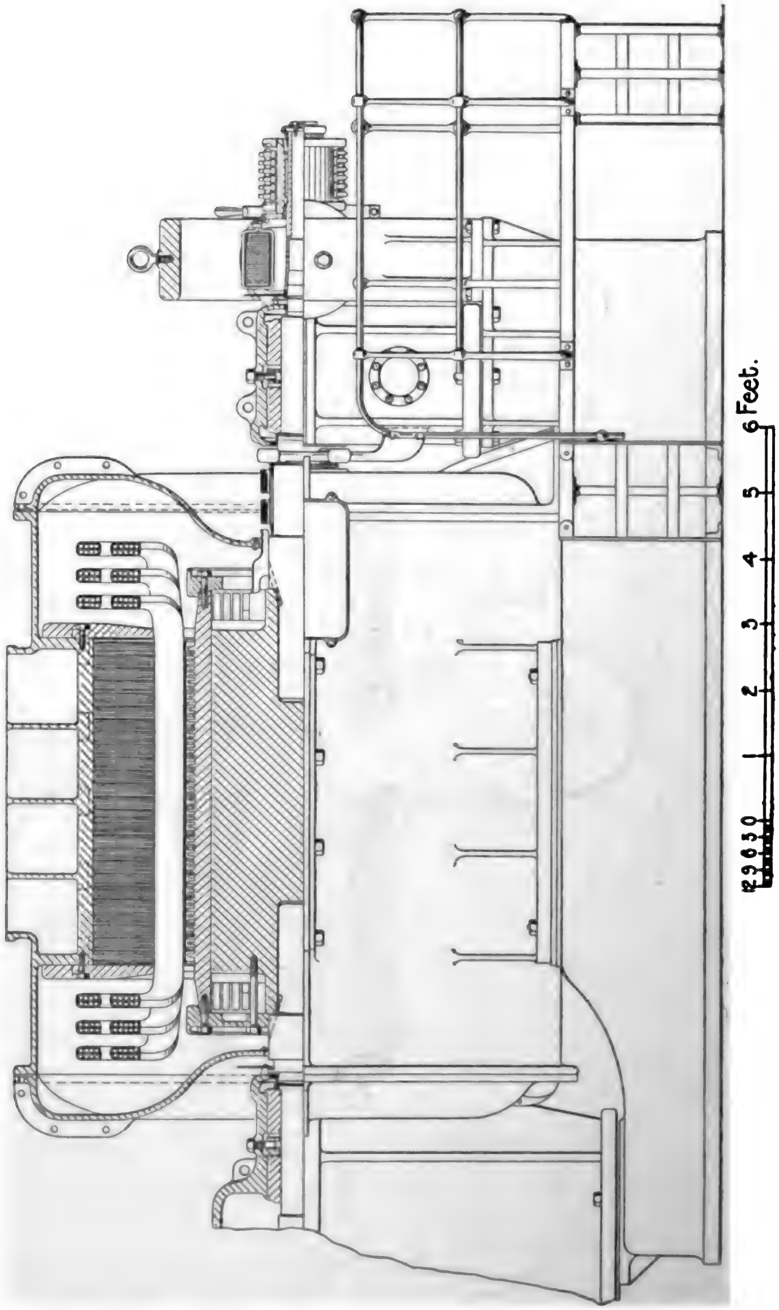


150-K.W. Single-phase Turbo-Alternator Armature, showing Air-cooling Ducts.

compensating winding enabled a dynamo with such winding to be increased in output from about 200 kilowatts to 500 kilowatts, and that 50 per cent. without sparking of the brushes, or having to shift them in any way.

I may further say that we have found in our

Fig. 9.



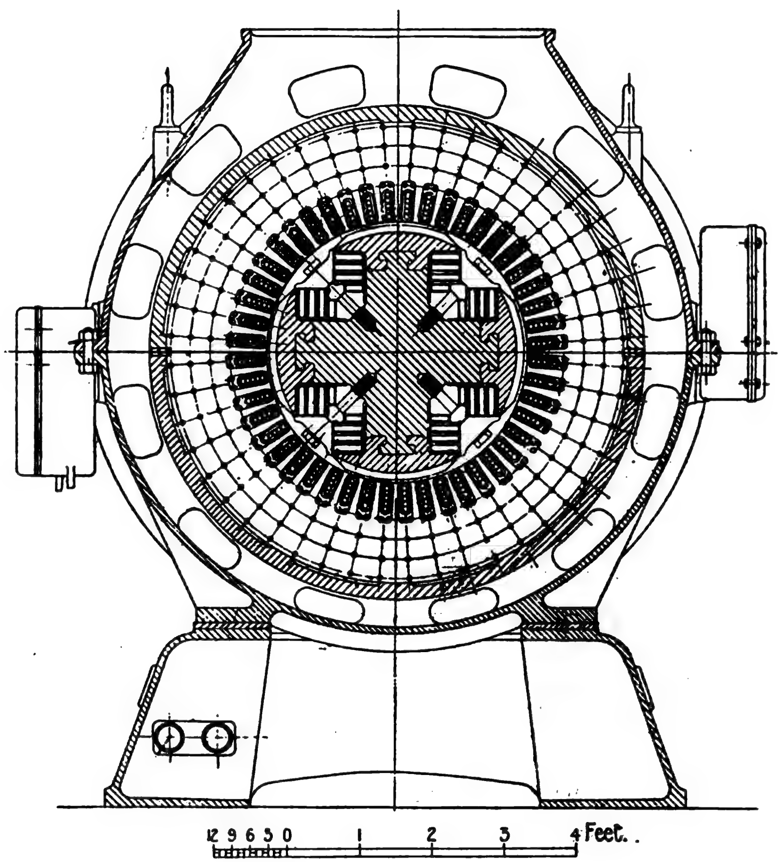
4,000-K.W. 3-Phase Turbo-Alternator with Exciter 6,000 volts.

without any shifting of the brushes such as was formerly necessary. Fig. 6 shows a 750 kilowatt turbo-generator built on the lines described above, and this can carry overloads of experience, two-pole turbo dynamos to be much more satisfactory than four-pole, and to cost little more to build, the two-pole proving to be much less liable to flash over than the

four-pole; in fact with our modern two-pole turbo dynamos such a thing as flashing over is unknown.

Turbo alternators were started rather later than turbo dynamos, the first being made about 20 years ago for the Newcastle and District Electric Lighting Company, Limited, four sets being installed in their Forth Banks station. These early alternators consisted of a smooth core having the windings laid over it and held on by binding wire, the ends being connected to slip rings, and were as a rule single phase. The size gradually increased up to 1,000 kilowatt single phase, and a voltage of 4,000 volts. Two of these early machines are shown in Figs. 7 and 8. It was found, however, that with high voltages, and especially when two or three phase alternators had to be built, the difficulties of manufacture and of insulation were very great, and therefore the type with revolving field magnets was adopted. Figs. 9 and 10 shows a 4,000 kilowatt three-phase turbo alternator for 6,000 volts., 40 periods, running at 1,200 revolutions per minute, and I may say that eight of these are installed in the Carville Power Station of Newcastle-upon-Tyne Electric Supply Company, Limited, in connection with the great power distribution in the North of England. The stator is of the usual type of laminated iron, the only noticeable point being that the end windings have to be very firmly stayed to stand up against the very heavy stresses which are occasioned if there is a short circuit or other sudden rush of current. The rotor consists of a steel casting with forged steel pole tips, the coils being separately wound and slipped on in place, after which the pole tips are put on and strong nickel steel bolts with manganese bronze keeps are used to counteract the tangential component of the centrifugal force. This rotor may be said to be typical of what is called the

FIG. 10.



4,000-K.W. 3-PHASE TURBO-ALTERNATOR, 6,000 VOLTS. (Cross Section.)

"salient pole formation," but there is also what may be called the "barrel" or "drum" type, which was first introduced by Mr. C. E. L. Brown, of Baden, Switzerland, in which the rotor consists of a series of plates with the winding embedded in slots in the outer circumference. It is a moot point which form is best, some having advantages in one way and some in the other, and which will eventually survive depends both on ease and cost of manufacture as well as mechanical and electrical advantages, and up to the present this point has not been settled. As in the case of continuous current machinery, one object is to get the maximum output at the highest speed possible, and since the materials available limit the length and diameter of rotor and therefore the available flux and the ampere turns, these again limit in the stator the output which can be obtained with a certain inherent regulation.

ordinary steam turbine when driven backwards does not act as an air compressor, but if the blades are suitably shaped it forms a very efficient one, and this fact has led to a large development in the application of steam turbines.

A section through such a compressor combined with its turbine is shown in Fig. 13, and it is seen that the compressor is very similar in construction to the steam turbine, having blades fixed on a revolving drum, and in a cylinder, which in this case on account of the small amount of compression to be done on the air are of uniform diameter. A dummy piston to balance the end pressure of the air on the moving blades is provided as in a steam turbine.

Such turbo blowing engines are largely used for blast furnaces, the blast pressures required ranging generally from 10 to 16 lbs. per square inch. One great feature of the turbine system is the way in which the blower adapts itself to

FIG. 11.

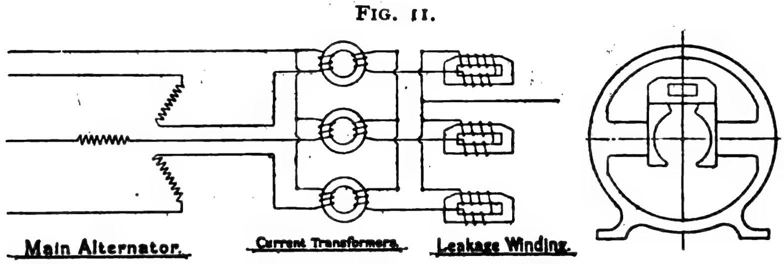


DIAGRAM OF CONNECTIONS. (Leakage Winding.)

A much larger output can be obtained by the adoption of some form of compounding which enables regulation again to be made as good as is desired. There are several means of doing this, one which is often used being the "Tirrill" regulator, where moving contacts regulated by the voltage of supply alter the excitation of the alternator. Another method which we have largely used is what we call a leakage path winding, shown diagramatically in Fig. 11, and this is a small yoke being put across the poles of the exciter round which the main current passes, and when this current increases it chokes back the magnetism and thus raises the voltage of the exciter. The effect of it is shown in Fig. 12 (p. 973), where will be seen the great difference in the regulation of the alternator with or without leakage paths.

An important development during the past few years has been the application of the steam turbine for driving air compressors. An

the requirements of the furnace. Should the resistance of the furnace diminish more air is at once automatically delivered by the turbo blower without the possibility of the engine racing. In fact the speed of revolution remains quite constant over a wide range of duty. Should, on the other hand, the resistance of the furnace increase, the quantity of air will be diminished and the pressure automatically increased. When what is known as "hanging" takes place it is an easy matter to speed up the turbine engine until the furnace is blowing freely. Usually about twice the normal working pressure can be obtained by this method.

Iron masters who use turbo blowers find that they can always get more iron from the furnaces when a turbo blower is supplying the blast than when it is supplied from a reciprocating engine. It is thus seen that the great elasticity and adaptability of such engines together with the steady blast is a great advantage in metallurgical work.

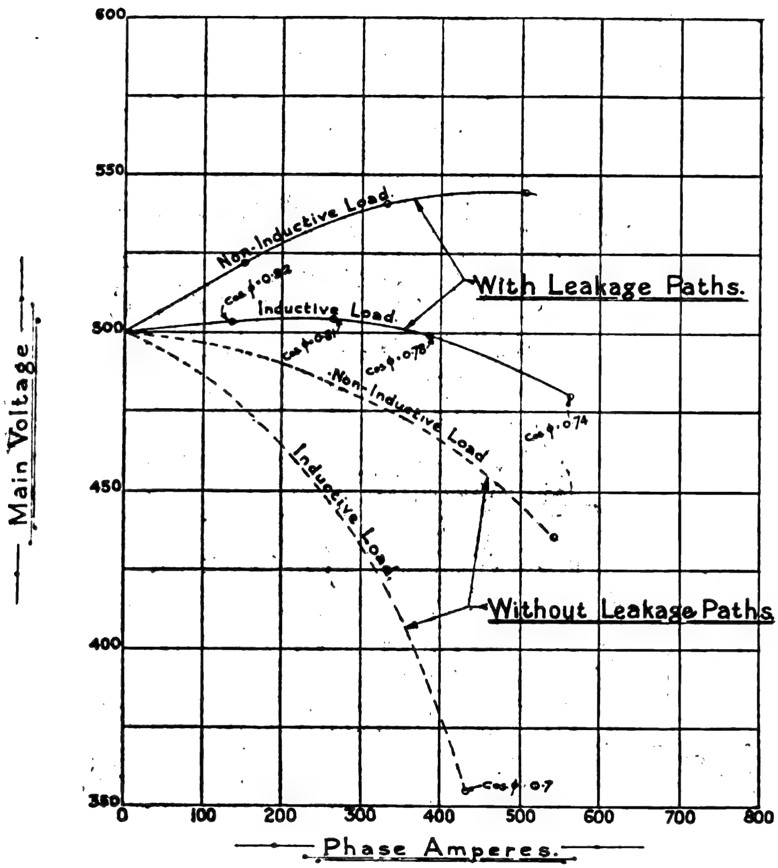
Fig. 14 (p. 975) shows an engine room in which both ordinary reciprocating blowing engines and tubine blowing engines are installed. The reciprocating engine is somewhat smaller in output than the turbine, and it is at once obvious what an enormous saving in space is effected by the use of the turbine engines. Further, it may be mentioned that the weight of the turbo-blowing engine complete is 25 tons, and the weight of the reciprocating engine 430 tons, or seventeen times heavier than the turbine.

A very useful size of plant is that built to deliver 20,000 cubic feet of free air per minute at 10 lbs. to 15 lbs. blast pressure. This size is suitable for blowing the average English blast furnace, and takes about 15,000 lbs. of steam per hour at 150 lbs. steam pressure, 100° superheat, and 28½″ vacuum, barometer 30″. From these figures it may be seen that turbo blowers are exceedingly economical. Besides iron smelting turbo blowers are used for copper refining and other metallurgical work. Small size turbo blowers are often driven by electric motors running at high speeds.

For producing pressures higher than 25 lbs. per square inch, the design of the blowing engine is usually of the centrifugal type, and consists of a number of centrifugal fans specially constructed to withstand the stresses caused by the high speed of revolution. The fans are arranged to blow in series, the pressure being slightly increased at each fan until the desired pressure is obtained, and in this way blowers are built to give 80 lbs. pressure, and above. This type of machine is used principally for mining operations, such as supplying compressed air for rock drills and coal-cutting machinery, and is found to be very economical.

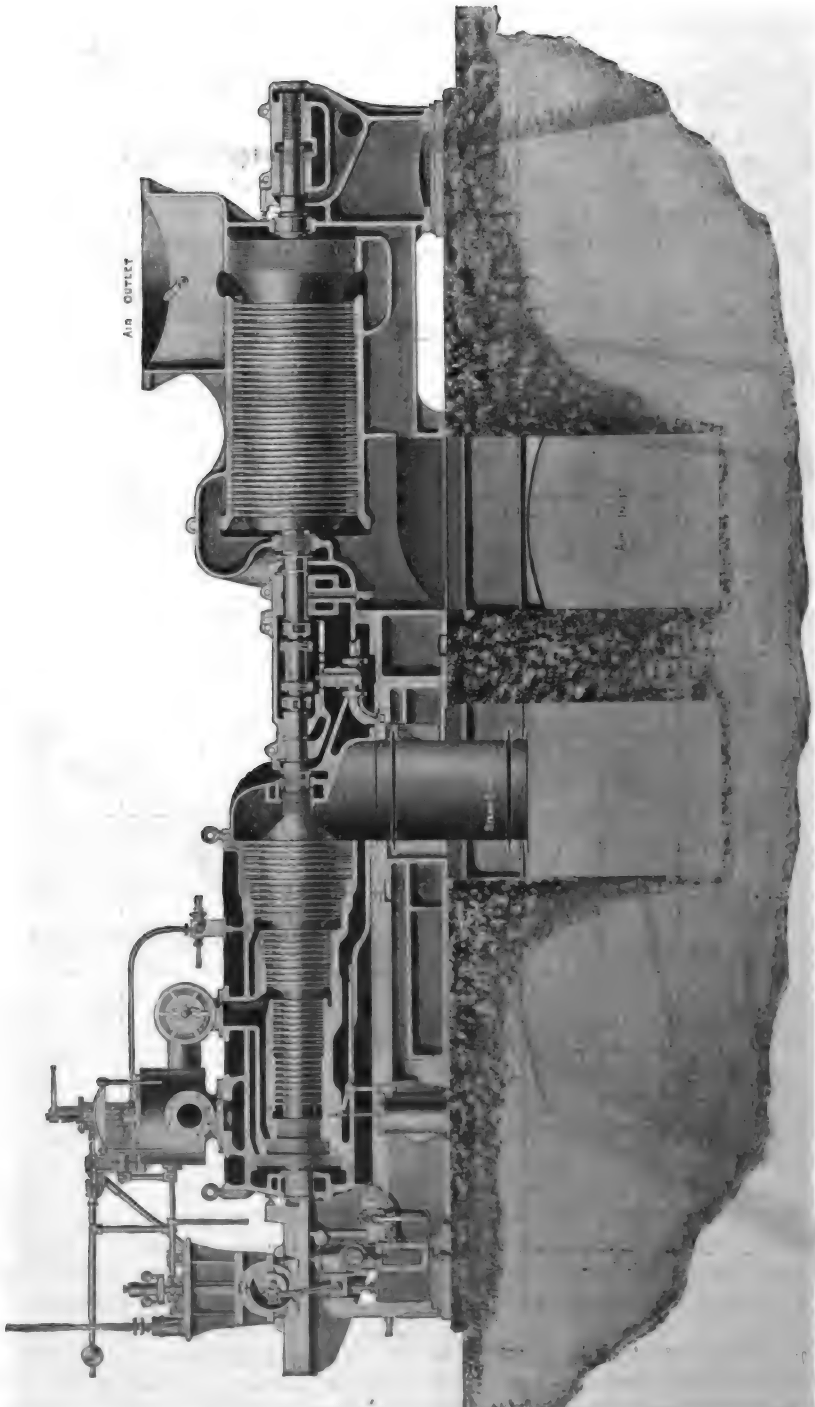
The fans are generally arranged in two cylinders, a high and a low pressure, with an

Fig. 12.



450-K.W. Turbo-Alternator Voltage Regulation Putting on Load. (Rheostats unaltered.)

FIG. 13.

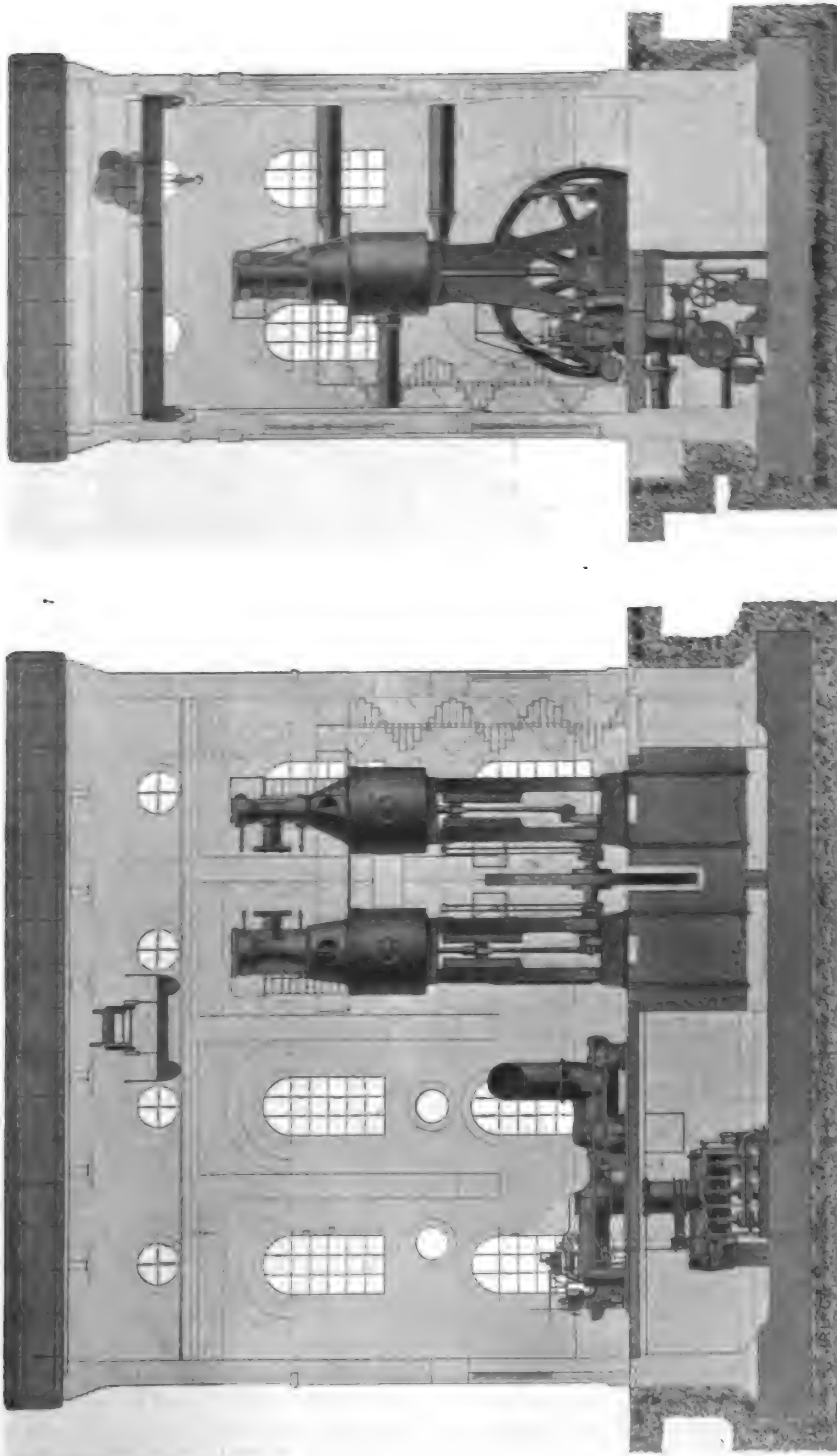


TURBO-BLOWING ENGINE. (Section through Steam and Air Turbine Cylinders.)

intercooler between them. The air is also cooled during compression by water-jacketing the cylinder.

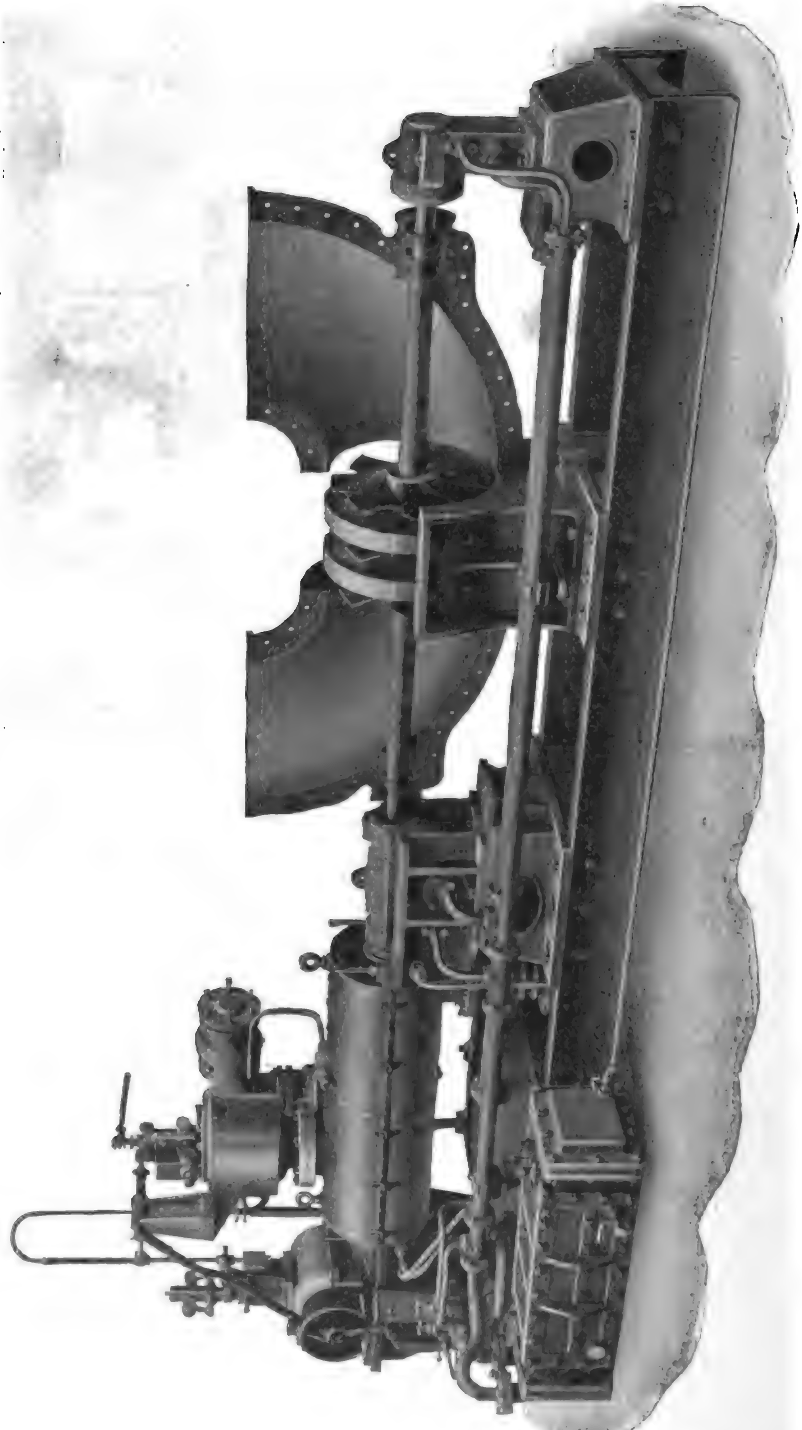
A further development of the turbo compressor is for dealing with large volumes of gas or air at low pressures, and a number of this type designed to deal with about 30,000 cubic feet free air per minute at about 1 lb. pressure, have been made. They are used principally for drawing exhaust gases from

Fig. 14.



Installation of Turbo-blowing Engine and Condenser.
(Showing the saving of space occupied by Turbine over the Reciprocating Engine of equal output.)

Fig. 15.



Showing Portions of the Exhauster Casing Removed so as to Expose the Propellers and Guide Blades.

blast furnaces, and driving them through the by-product recovery plant. The gases from blast furnaces, more especially the Scotch blast furnaces, where coal is used instead of coke, are heavily charged with tar, ammonia, &c., and the usual form of reciprocating compressor has been found to be very troublesome, due to choking up, but since the turbo-machine came out, most gratifying results have been attained, the plants running for many months,

night and day, without ever being shut down.

Another application is that of boosting up the pressure of coal gas in the gas mains of large towns. Sometimes it is found that owing to the extension of a town the mains become too small. The introduction of small turbo blowers enables a large amount of gas to be forced through the small mains, and thus saves the heavy cost required to lay down additional mains to meet the increased demand for gas in the outlying districts.

In the Glasgow Corporation Gas Works, a small turbo blower is used for pumping gas down hill: this may seem rather paradoxical, but it must be remembered that coal gas is lighter than air, and therefore it has to be pushed down hill by mechanical means. The construction of this latter type of blower or exhauster as the case may be, is shown in Fig. 15. It will be seen that the particular machine illustrated, consists of three screws, very much like the propellers of a ship, only having more blades. Between the propellers, spiral guide rings are fitted. The power required to drive these machines is generally about 150 horse-power, and the speed of revolution about 7,500 revolutions per minute, varying of course with the size and duty of the engine.

EARLY STEAM NAVIGATION.

Mr. R. C. Seaton, writing to *The Times* Engineering Supplement on October 3rd, draws attention to the following paragraph in "Carlyle's Reminiscences" (Vol. I., pp. 128-130) on the subject of early steam navigation:—

"At Greenock I first saw steamers on the water; queer little dumpy things, with a red sail to each, and legible name, *Defiance*, and such like, bobbing about there, and making continual passages to Glasgow as their business. Not till about two years later (1819 if I mistake not) did Forth see a steamer; Forth's first was far bigger than the Greenock ones, and called itself *The Tug*, being intended for towing ships in those narrow waters, as I have often seen it doing; *it* still, and no rival or congener, till (in 1825) Leith, spurred on by one Bain, a kind of scientific half-pay Master R.N., got up a large, finely-appointed steamer, or pair of steamers, for London; which, so successful were they, all ports then set to imitating. London alone still held back for a good few years; London was notably shy of the steamship, great as are its doings now in that line. An old friend of mine, the late Mr. Strachey, has told me that in his schooldays he at one time—early in the nineties I should guess, say 1793—used to see, in crossing Westminster Bridge, a little model steamship paddling to and fro between him and Blackfriars Bridge, with steam funnel, paddle-wheels, and the other outfit, exhibiting and recommending itself to London and whatever scientific or other spirit of marine adventure London might have. London entirely dead to the phenomenon, which had to duck under and dive across the Atlantic before London saw it again, when a new generation had arisen. The real inventor of steamships, I have learned credibly elsewhere, the maker and proprietor of that fruitless model on the Thames, was Mr. Miller, Laird of Dalswinton, in Dumfriesshire (Poet Burns's landlord), who spent his life and his estate in that adventure, and is not now to be heard of in those parts; having had to sell Dalswinton and die *quasi*-bankrupt (and I should think broken-hearted) after that completing of his painful invention and finding London and mankind dead to it. Miller's assistant and work-hand for many years was John Bell, a joiner in the neighbouring village of Thornhill. Miller being ruined, Bell was out of work and connexion, emigrated to New York, and there speaking much of his old master, and glorious unheeded invention well-known to Bell in all its outlines or details, at length found one Fulton to listen to him: and by 'Fulton and Bell' (about 1809), an actual packet steamer was got launched, and, lucratively plying on the Hudson River, became the miracle of Yankeeland, and gradually of all lands. These I believe are essentially the facts. Old Robert McQueen of Thornhill, Strachey of the India House, and many other bits of good testimony and indication, once far apart, curiously coalescing and corresponding for me. And as, possibly enough, the story is not now known in whole to anybody but myself, it may go in here as a digression—*à propos* of these brisk little Greenock steamers which I first saw, and still so vividly remember, little *Defiance*, &c., saucily bounding about with their red sails in the sun, on this my tour with Irving."

The interesting point about the paragraph is that these reminiscences of Carlyle do not seem to have previously attracted the attention of writers on early steam navigation. Their publication is indeed subsequent to that of the principal authorities. Probably all that is to be said on the subject has been said long ago, and there is no great likelihood of any fresh information coming to light.

Interesting and picturesque as Carlyle's remini scences are, they contain several inaccuracies. He was not correct in supposing that it was Miller's model which ran on the Thames about 1793. This was really Rumsey's boat, described in his patent of the 6th of November, 1788. Rumsey was an American who came over to England to push his invention. Woodcroft says it was on account of his being unable to obtain a patent in America. but according to Thurston, he obtained a patent from the State of Virginia in 1787. After two years in preparations "he was on the eve of putting the last hand to his steamboat when he died."

(Woodcroft on "Steam Navigation"). He was explaining a friend's invention to a committee of the Society of Arts in 1792 when he was struck by an attack of apoplexy, which caused his death in a few hours. The vessel was, however, got afloat in February, 1793, and was "sailed many times on the Thames against wind and tide with the speed of four knots an hour." The boat is fully described in Woodcroft's paper on "Steam Navigation" in the Proceedings of the Society, Vol. LVI., 1846-8.

Miller's historical experiment on the Dalswinton lake was carried out in 1787. The steam engine used was Symington's. No reference to John Bell appears in Woodcroft, or in the very full memoir of Miller in the "Dictionary of National Biography" (by Mr. R. B. Prosser); nor is he mentioned by Galloway or Thurston in their histories of the steam engine. Henry Bell, whose *Comet*, launched in 1812, ran regularly for some time between Greenock and Glasgow, is said by Galloway "to have obtained information from Fulton," but no authority is given for the statement. Fulton's *Clermont* was launched in 1807 in New York, with an engine supplied by Boulton and Watt.

The statement that Miller sold his property and died insolvent is certainly incorrect. He died at Dalswinton in 1815, and the division of his property among his children was the subject of a lawsuit, which was carried to the House of Lords.

The first practical steamboat was, without much question, the *Charlotte Dundas*, which, in 1802, was tried on the Forth and Clyde Canal, and would have been adopted for use on that canal, but for the fear of the proprietors of damage to the banks, and on the Bridgewater Canals, but for the death of the Duke of Bridgewater.

The whole question of the origin of steam navigation has been a little obscured by the patriotic proclivities of American and English historians. Probably the history may be summarised as follows:—The first experimental vessel successfully driven by steam was that of Miller, who, in 1787, at the suggestion of Taylor, fitted a Symington engine into his double-hulled boat, and worked it on Dalswinton Lake. The second—still experimental—was Rumsey's boat, which was tried on the Thames in 1793. The first practical steamboat was Symington's *Charlotte Dundas*, which successfully ran, and towed boats on the Forth and Clyde Canal in 1802. The first steamer which ran regularly and continuously was Thomas Fulton's *Clermont*, 1807. The first regular passenger steamer in Europe was Henry Bell's *Comet*, 1812. H. T. W.

THE BY-PRODUCTS OF INDIAN FORESTS.

It has been demonstrated by numerous experiments in Europe as well as in America that the pulp possessing the best fibre for paper, and the most practicable to make is that derived from the wood of the spruce and fir. In India there are spruce and fir which yield as good paper pulp as any in Europe or America, as has been amply proved by experiments. Large quantities of this timber in India will run 4 feet and 5 feet in diameter, 4½ feet from the ground, and 150 feet to 200 feet in height. They not only do not use a stick of this, but even, in some places, they girdle it and allow it to rot, just to favour a few deodars (*Cedrus deodara*) growing under it. The reason for this is the difficulty of securing the timber, which could be overcome by energy and enterprise. The difficulty of removing the timber is due to the extremely rugged nature of the country, the steep slopes and gorge-like valleys rendering the construction of railways, or even cart roads, so expensive as to be practically out of the question, except for very large operations. The American Consul-General at Calcutta, who has been studying the forests of India, and incidentally their properties as pulp and turpentine producers, says that though the amount of material obtained per acre would be small on account of the forest conservation by the Government, this could be overcome by establishing a wood-pulp mill on one of the main streams, such as the Jumna or the Tons—or, preferably, at their junctions—so as to tap a larger area. From there the manufactured product, either pulp or finished paper, could easily be shipped by rail. The difficulty of the number of small operations would be overcome by the extreme cheapness of the labour. Felling with the primitive tools used costs less than two shillings per 1,000 feet, board measure, and carriage by coolies costs about one penny per cubic foot per mile. The rolling down hill would cost practically nothing. The advantages which the wood-pulp industry would enjoy would be an absolutely assured and permanent supply of raw material, on account of the conservative management by the Government of the forests from which the material is derived, and the favour and help of the Government in forwarding the enterprise, which is only too anxious to have it succeed, so as to furnish a market for the spruce and fir, which at present are rotting, and going to waste. Another advantage, especially important for an industry in India, is the favourable climate. On account of the elevation at which the tree occurs, the climate is such that the work can be carried on by white men, without danger to their health, or impairment of efficiency, all the year round. Here, then, is said to be an opportunity of developing an industry which would be not only extremely profitable, but absolutely sure and permanent when once started. As regards a turpentine industry, the making of turpentine in India offers even a more inviting field for enterprise then the pulp industry, because it has been tried long enough for all the figures and details to be fully known. Turpentine in India is derived from the chir, or long leaf pine, which very much resembles the American long leaf pine, from which the main supply of turpentine of the world is derived, and which is rapidly disappearing. The tree occurs in different parts of the

Himalayas at elevations of from 3,500 to 7,000 feet. It is worked in several localities, but most at Bohwali, near Naini Tal, in the United Provinces. Here the Government have been tapping and distilling since 1900. The work of tapping is well organised, and the distillery is fitted up with most of the modern improvements. From one maund (82 pounds) of crude resin, one gallon and a-half of turpentine is obtained, and fifty-three pounds of resin. This yields a profit of about five shillings and sixpence per maund. It takes about seven trees to produce a maund in a year, thus giving a profit of about ninepence per tree per annum. This comprises everything except interest on the capital. In the Bohwali district there are more than 300,000 trees available. The Consul says that the Government is now trying to sell out because its policy has always been to encourage a new industry by undertaking it itself, and demonstrating that it is profitable, then stepping out and giving it over to private enterprise, because it wants every industry to be in the hands of private individuals as far as possible. The Consul adds that there is an opportunity here to buy up an industry already developed, the profit of which has been clearly proved, and one which is bound to increase in value and extent, because it has only just passed the experimental stage, and they are still tapping much more slowly than there is any need for.

ORIGIN OF SHEFFIELD PLATE.

There is nothing in art so entirely English as the making of Sheffield plate, mezzotint engraving not excepted. The fusing of silver on to copper was known to the ancient Peruvians, possibly to other nations, but as far as Western civilisation is concerned the discovery was made by that "ingenious mechanic," Thomas Bolsover, in 1732. Like many other important discoveries, that of Bolsover was the result of an accident. One day when repairing a piece of plate he is said to have used a penny to "cramp" up a join, and allowing his work to become overheated, found that the two metals had fused and become inseparable.

In the middle of the eighteenth century silver was costly, and Bolsover conceived the idea of beating out a thin layer of the precious metal and fusing it on to a copper foundation, thus producing something cheaper than silver plate and better than pewter.

In a few years from Bolsover's discovery the making of Sheffield plate had become a flourishing industry, and the workers, "as a body, most unsteady, depraved, and idle," earned such high pay that two are said to have kept hunters, whilst others employed a hairdresser to attend them during working hours "with his paraphernalia, powder, and all." But this was the golden age produced by the scarcity of capable workmen. Soon a class of skilled mechanics sprang up, and masters were no longer forced to bid against each other for the possession of craftsmen capable of carrying on the new and popular industry. —*The Art Craftsman.*

HOME INDUSTRIES.

Banks and Home Industries. — Attempts have been made during the discussion of the Development Bill in the House of Commons to induce the Government to promise support to industrial banks intended to assist farmers and others, but nothing definite in this direction has been achieved. In Germany the greatest assistance has been rendered to agriculture by the Raiffeisen credit banks, which have gone far towards the solution of an agricultural difficulty in this country—the lack of easy and advantageous ways of procuring ready money when it is most needed. There are the legitimate banks and the loan agencies, good and bad, but in resorting to either the farmer is compelled to pay a high rate of interest, and without substantial security he cannot succeed in borrowing money at all. In Prussia one of the most useful auxiliaries of the co-operative credit societies is the institution known as the Central Co-operative Bank, a State institution established with ample resources for the purpose of providing needy co-operative credit societies with funds. Probably before many years have passed something of the sort will be tried in this country. Nor is it only agriculturists who complain of the lack of banking accommodation in the United Kingdom. The growth of the joint stock banks, with the consequent disappearance of the private banks, has resulted in industrial concerns being nowadays unable to get that financial assistance which the private banks accorded them, and which is to be got in full measure in Germany and other Continental countries. The joint stock banks are content to earn their dividends on the exchange and discounting business, and look askance at industrial issues which may involve speculation and risk. As a writer in *The Times* points out in an interesting communication (October 9), the banks are not interested in industrial undertakings to the extent that they used to be in this country and still are on the Continent. "In times past the banks in manufacturing towns were privately owned, the banker was interested in local manufacturing concerns, probably having a seat on the board of directors, and when large contracts had to be undertaken, or times of stress arose, the manufacturer could rely upon the support of the local bank." But with the disappearance of the private bank this assistance disappears. The local banks have now been amalgamated with the big London banks, and co-operation with local industries has ceased. The local bank manager has become a paid official, little better than a clerk, liable to be moved about at any time, and having to refer to London upon all matters not of the merest routine. The authorities in London are not to be blamed, for, to use a homely adage, they have to cut their coat according to their cloth. The banking business of the country is based on a dangerously low gold reserve, the trading capital belongs to the depositors, and is mostly repayable on demand; and the paid-up capital of the shareholders

is very small in comparison with the business done. But this state of things is seriously affecting the home industries of the country. The writer already quoted goes so far as to say that "the effect has been that in certain classes of work in London, where finance and contracting have to go together, it has become a rule that 'no British firm need apply,' not because Continental machinery is cheaper or of better quality than the English, but because the Continental manufacturer, thanks to the support of his banking institutions, is able to take up concessions, finance work, and accept terms of payment at which the English firm cannot look. It used to be said that "trade follows the flag;" it is truer, however, to say that it follows the bank.

Mushroom Insurance Companies.—The report of the Comptroller of the Companies' Department of the Board of Trade, just issued, refers to the insurance companies which passed into liquidation last year. Their history affords additional proof of the need for the strengthening of the law relating to insurance companies which the Insurance Bill now before Parliament is intended to provide. The British United Insurance Corporation, Limited, lived just two years and five months. Its only capital was the sum of £2,690 derived from £3,590 share capital issued. With these slender means the company accepted unlimited risks (estimated roughly at £1,100,000), and undertook insurances of almost all kinds, including endowment and house purchase. Life insurance was not undertaken, so that no statutory deposit of £20,000 was necessary. Efforts were made to obtain more funds without success. The usiness was carried on recklessly in the meantime, all risks offered being accepted, with the inevitable result of failure. The other case was that of the Casualty Insurance Company, Limited, registered in February, 1904, with a nominal capital of £60,000, for the purpose of carrying on the business of personal accident and sickness insurance. The subscribed capital was £13,595, of which only £5,528 10s. was paid up. Not undertaking life insurance, no deposit could be required of the company prior to commencing business, and its uncalled capital of £8,047 therefore formed the only reserve to meet losses which might arise of an unusual nature. In cases where the company insured against fatal accidents re-insurances were effected by it with other companies, but the small capital available proved quite insufficient, with the result that it was all lost, and the creditors will receive no more than a very small dividend.

Monster Steamships.—The Cunard Steamship Company having beaten the record with regard to size and speed in the construction of the *Mauretania* and *Lusitania*, the White Star Line are building two steamers for the North Atlantic Service which in point of size leave all vessels now afloat far behind. The tonnage of the *Mauretania* is 33,000 and the *Lusitania* is a sister ship, but the tonnage of the *Olympic* and *Titanic* is to be 45,000 tons though with a speed of only 21 knots as against the 25 of the Cunard boats. The new steamers, which will be completed about the end of 1910, will sail on the Southampton-New York Service, and will have a displacement of 60,000 tons. They are to be 840 feet long, with a beam of 90 feet, and the boat deck will be more than 60 feet above water. Their carrying capacity will exceed that of any existing ship by at least one-third, and they will carry more than 5,000 persons all told, the crew of each exceeding 600 in all. Nor is it only in size that the vessels will beat the record. They will be more elaborately fitted than any now afloat. The passenger may well imagine himself in a sumptuous hotel ashore. There will be not only suites of rooms but complete flats at his disposal if he cares to pay for them; cabins with private shower baths attached: a magnificent gymnasium; a verandah café on one of the upper decks 50 feet above the water; a palm garden, and a garden on the fore deck. Each boat will be divided into upwards of 30 steel compartments separated by heavy bulkheads. Another set of safety devices will guard against fire. A combination of turbine and reciprocating engines will propel the vessels, and this arrangement is expected to effect a great economy of coal.

Short Time in the Cotton Trade.—The International Federation of Master Cotton Spinners' and Manufacturers' Associations has issued the statistics which it has collected showing the consumption of cotton in the world in the year ended 31st August last, and the stocks of cotton in spinners' hands at that date. In some of the principal countries the actual mill stocks of American cotton are considerably larger than appeared from the estimates recently made by some authorities. On the 31st August the stocks in actual bales reached a total of 3,183,392, as against 2,728,045 a year before, 3,334,410 in 1907, and 1,210,610 in 1906. The American stocks were 908,000 bales. Russia came next with 345,644. The British total was 331,741, and Germany's 333,669. An interesting part of the return is that which deals with short time. The short time movement initiated by the International Federation is now adopted by almost every country of the world. No figures have been cabled from the United States as to short time, but it is known that during part of 1908 a considerable amount of short time was worked in America, and that a number of spindles were stopped throughout the year. Tables given by the Federation estimate the total number of spinning spindles at work in the world in the past year at 131,503,062, of which 53,311,630 are credited to Great Britain, 10,162,908 to Germany, 5,800,000 to India, and 27,783,000 to the United States. The number in France is put at 7,000,000, and in Russia at 7,800,000, Japan having 1,496,698.

The American Cotton Crop.—The two reports from the United States Government just issued upon

the cotton crop of the present year do not throw much light upon the situation. From the first of these it appears that up to September 25th there had been ginned of the present American crop 2,562,000 bales, as compared with 2,590,639 bales at the corresponding time last season. These figures do not in themselves bear out the reports of a greatly diminished supply. But it is said by those who predict a short crop that hot weather has forced the cotton into a premature fruition, and that in some districts at least the period of growth will be abnormally short. The high prices, too, are said to have stimulated the movement to market. Nor does it necessarily follow that a large September movement means a large crop. The second of the two reports mentioned above, which seeks to obtain an average "condition" of the crop, or such part of it as was ingathered on September 25th, cannot be said to be encouraging. This condition is given as 58·5 per cent. of the possible, or rather impossible maximum contemplated by the Government office, and it compares with 69·7 per cent. last year. The one safe prediction at present about the current year's cotton crop seems to be that it will not be a big one.

CORRESPONDENCE.

KAPOK LIFEBELTS IN THE ROYAL NATIONAL LIFEBOAT INSTITUTION.

With reference to the article entitled "The Production of Kapok in Java," which appeared in the *Journal* on July 23rd, 1909, Commander W. Holmes, R.N., Chief Inspector of Lifeboats, has kindly supplied the following information relating to the use of kapok life-belts by the Royal National Lifeboat Institution:—

In the year 1904 kapok was brought to the notice of the Committee of Management of the National Lifeboat Institution as a substitute for the cork used in the life-belts invented by the late Admiral J. Ross Ward in 1854, and supplied to lifeboat crews ever since that date. After experiments had been made and a pattern life-belt approved, the kapok belts were sent to 10 coast stations for trial on service, and the coxswains and crews were especially invited to express their opinion on them. In July, 1906, reports were received after the belts had been 12 months on the coast, and the coxswains and crews all spoke most highly of them, much preferring them to the old cork belts, the chief points in favour of the kapok being lightness, more freedom to work in, ease in putting on, comfort, and warmth. The Committee of Management thereupon adopted the kapok life-belt for all future supplies, and at this time (1909) there are not many cork belts left on the coast. The following details will illustrate the great advantages of kapok:—

	Average weight.	Tested to support in water 24 hours.
Cork belts	6 lbs.	...... 22 lbs.
Kapok belts ..	3 lbs. 12 oz.	...... 25 lbs.

The requisite qualities of a lifeboat man's life-belt are:—

1. Extra buoyancy of 22 lbs. sufficient to support a man heavily clothed, with his head and shoulders above the water, or to enable him to support another person besides himself.

2. Perfect flexibility, so as readily to conform to the shape of the wearer.

3. A division into two zones, an upper and a lower, so that between the two, it may be secured tightly round the waist; for in no other manner can it be confined sufficiently closely and securely round the body without such pressure over the chest and ribs as to affect materially the free action of the lungs, impede the muscular movement of the chest and arms, and thereby diminish the power of endurance of fatigue, which in rowing boats is a matter of vital importance.

4. Strength, durability and non-liability to injury.

All the above conditions are satisfied far better by kapok than by cork in the construction of lifebelts.

OBITUARY.

Richard Bannister.—Mr. Richard Bannister, who had been a member of the Royal Society of Arts since 1886, died at the age of 74 on the 27th ult. Mr. Bannister was a student under Dr. Hofmann at the Royal College of Chemistry, and entered the Government Laboratory in 1862. In 1874 he became Deputy Principal of the Laboratory under the late Dr. Bell. He retired from the Government service in 1898. Mr. Bannister was one of the first shareholders of the Civil Service Supply Association, and after serving for several years on the Committee of Management, he became Chairman in 1886; he held this office up to the time of his death.

He was a recognised authority in all matters connected with the chemistry of food, and had great practical knowledge of the subject. He served as a Juror at the Health and Inventions Exhibitions, at South Kensington, in 1884 and 1885, and contributed a report on wines, &c., to the volume of Reports on the Colonial and Indian Exhibition, 1886, published by the Society of Arts for the Royal Commission of that Exhibition. He was also a Juror at the two last Paris Exhibitions, 1889 and 1900, and at Chicago in 1893. He was often called upon to give evidence before Royal Commissions and Departmental Committees dealing with food and similar subjects, and had great experience as an expert witness in Revenue cases.

Mr. Bannister gave the Society two courses of Cantor Lectures, one in 1888 on "Our Milk, Butter, and Cheese Supply," and the second in 1890, on "Sugar, Coffee, Tea and Cocoa." He also, in 1887, read a paper on "Colonial Wines," for which he was awarded a silver medal.

NOTES ON BOOKS.

The Recognition of Minerals. By C. G. Moore, M.A., F.I.C. London: *The Mining Journal*. 7s. 6d. net.

The object of this book is to assist the traveller and prospector in distinguishing minerals of commercial value from ordinary rocks and stones. It originated in a series of notes made by the author when he was engaged as resident chemist to the Ashanti Goldfields Corporation, and additions have been made to it during professional journeys to Tasmania and elsewhere. Descriptions are given of most minerals of value, with hints on how to recognise them, the uses to which they are put, and the demand generally existing for them. Simple tests, such as can be easily performed in the field, are included, though no attempt is made to enter into detail into the various methods of assay, which are the province of the highly-trained mineralogist. The book should prove useful to that large number of travellers who are passing through mineralised districts in the less known parts of the world: even if it does not assist them to discover great riches it will repay them, as the author says, "in the added interest that such a study gives to residence abroad under conditions that are sometimes monotonous or unprofitable."

Botany of To-day. By G. F. Scott Elliot, M.A., B.Sc., F.R.G.S. London: Seeley and Co. 5s. net.

The "Science of To-day" series has already made its mark as giving excellent popular accounts of recent developments in various branches of science. The latest volume is worthy to rank with its predecessors, which dealt with astronomy, electricity, and physics. To recapitulate and describe in a lucid and readable form the present situation in the science of botany is no easy task, for perhaps in no field are more rapid strides being made at this time. Mr. Elliot estimates that over a quarter of a million printed pages, often of a very difficult and technical character, and written in eight or nine different languages, form the present yearly output of botanical writers; and with such frequency is new work being brought forward that between the printing and publication of this volume several books of the first importance appeared. But although this volume was written before the author had had an opportunity of seeing the English edition of Warming's "Oecology" and Seward's "Darwin and Modern Thought," it contains all but the very latest botanical theories, and the reader who has mastered it will have an excellent general idea of recent problems and discoveries of botanists.

Modern Cabinet Work, Furniture and Fitments. By Percy A. Wells and John Hooper. London: B. T. Batsford. 12s. 6d. net.

The aim of the authors has been to produce a book dealing fully with the modern developments and progress of the craft of cabinet-making, and to illustrate "step by step the practice of the craft in all its applications, from the making of a joint to the preparation, setting out, and complete construction of the numerous and various types of furniture and woodwork which the cabinet-maker is called upon to make." It will be obvious at once that the scope projected is a very wide one; and though probably no one is better fitted to undertake the task than Mr. Wells, whose paper on "English Furniture" won him the Society's silver medal last session, it may be doubted whether it was advisable to design a book which should appeal at the same time to the apprentice and journeyman, the foreman, draughtsman, and designer, the salesman, architect, and collector. The description and illustrations of tools, for instance, which may interest the apprentice, will hardly be wanted by the more advanced student. But when this piece of criticism has been offered, nothing but praise remains for the book. To give an idea of the pains which have been bestowed on its production, it may be mentioned that it includes 1,000 diagrams and measured drawings; more than fifty photographs of historic and modern work; and detailed descriptions of over two hundred woods used in furniture making, with notes on the growth and structure of timber, its diseases, shrinkage, seasoning, &c. A glossary of technical and workshop terms and a copious index complete a very handsome volume.

GENERAL NOTES.

Books on Agriculture.—Mr. A. D. Hall is publishing, through Mr. John Murray, a new edition of his book, "The Soil," and also a new work, "Fertilisers and Manures." The latter seems to embody with other material the information contained in the course of Cantor Lectures delivered before the Society by Mr. Hall.

Studentships at the School of Art Wood-Carving.—The School of Art Wood-Carving, 39, Thurloe-place, South Kensington, has been re-opened after the usual summer vacation. Some of the free studentships in the Evening Classes maintained by means of funds granted to the school by the London County Council are vacant. The holders of these studentships are selected by the London Council, and by the committee of the school, from persons of the industrial class who are intending to earn their living by wood-carving. Candidates must have passed at least one of the examinations of the Board of Education in freehand drawing. Those who have some knowledge of wood-carving, or have passed in other subjects of art, will be preferred. The day classes of the school are held from 10 to 1 and 2 till 5 on five days of the week, and from 10 to 1 on Saturdays. The evening class meets on three evenings a week and on Saturday afternoons. Forms of application for the free studentships and any further particulars relating to the school may be obtained from the manager.

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FRIDAY, OCTOBER 22, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

STEAM TURBINES.

By Gerald Stoney,
B.E., M.Inst.C.E., M.I.E.E.

Lecture III.—Delivered April 5th, 1909.

In the last two lectures a description was given of, firstly, the lines on which steam turbines are constructed and designed, and secondly, their various applications on land.

In this lecture some account is given of the greatest development in the application of the steam turbine, that is, to the propulsion of ships.

The large and increasing amount of horse-power, and the greater size and speed of the modern engines tend towards some form which shall be light, capable of perfect balancing, and economical in steam. The marine engine of the piston type does not fulfil these requirements. In January, 1894, a pioneer syndicate was formed to explore the application of the steam turbine to marine propulsion. It was deemed expedient, for reasons of economy and also of time (as many alterations were anticipated) to build as small a vessel as possible, but not so small as to preclude the attainment of an unprecedented rate of speed. The *Turbinia* was constructed, her dimensions being 100 feet in length, 9 feet beam, 3 feet draught of hull, and 44 tons displacement. She was fitted with turbine engines of 2,000 actual horse-power with an expansive ratio of 150-fold, also with a water-tube boiler of great power and of the express small tube type. The turbine engines consisted of three separate turbines—a high pressure, an intermediate, and a low pressure—each driving one screw shaft independently. To the low pressure on centre shaft the reversing turbine for going astern was also coupled, and on each shaft were keyed three propellers of small diameter and of normal pitch ratio. This arrangement was found to be the best after many trials. The maximum indicated horse-power that has been obtained on runs of about five miles duration has been 2,500, giving a speed of 34½ knots, but a speed of 31 knots can be maintained for about two hours' duration, and since she was completed she has run several thousands of miles, sometimes in very heavy seas, and the main engines have never caused a moment's anxiety, nor have any repairs to them been necessary. But before this result was obtained a great deal of trouble had been given by the phenomena of cavitation, which is the vacuum left behind the blades of a screw propeller if it is forced too hard through the water. If we put a stick into water and move it slowly, the water follows up the stick and closes in behind it, but if we move it too violently a space is formed in the water, as it cannot close in behind the stick fast enough. The same thing occurs in screw propellers if the forces applied to them are too great. Mr. Parsons investigated this in a very beautiful way by allowing an intermittent beam of light to fall on a model propeller at one part of its revolution, so that it seemed as if it were standing steady, and thus the cavities about the blades could be clearly seen and photographed.

Thus it will be seen that after three years' hard work and many failures the *Turbinia* was completed, and in her the problem of adapting the turbine to work a screw propeller was worked out and, like almost everything else in engineering, resulted in a compromise.

The screws were made of small diameter and with broad blades so as to avoid cavitation and yet revolve as quickly as possible, and the turbines were made short and of large diameter so as to revolve as slowly as possible. In order still further to make them adapt themselves to one another each shaft was fitted with three screws sufficiently far apart to prevent serious interference, and thus each screw had only to

absorb one-third of the power transmitted by the shaft; and also the turbine was divided into three—a high pressure, an intermediate, and a low pressure, so that there was only one-third of the expansion in each. This enabled the drums to be made short and of large diameter, and yet have a good height of blade so as to minimise leakage.

In the first lecture it was shown that for any given amount of expansion and a given velocity ratio, a certain spindle volume was necessary for good economy. By thus dividing up the turbine into three parts each had only one-third of the total volume, and at the same time the blades were three times as high as if there were three separate turbines, each with drums of the same diameters as the divided ones. Also, since the expansion in each is moderate, there is no need to step the drums, and thus they are cylinders of one diameter only, very short and stiff, and enabling fine clearances to be used.

The total result was that the weight was probably about one-third and the leakage one-quarter of what there would have been with three separate turbines, each having the full expansion carried out in it, and it was this dividing up of the turbines that more than anything else made the *Turbinia* the success she was. A separate stern turbine was fitted on the centre shaft for going astern. After the *Turbinia*, the *Viper* and *Cobra*, torpedo-boat destroyers, followed, but the next great step was the introduction of the turbine into the Mercantile Marine.

Many conferences were held between Mr. Parsons, Mr. Archibald Denny, and Captain John Williamson, and finally, as a result, the *King Edward* was built in 1902 at Dumbarton, the engines being made by the Parsons Marine Steam Turbine Co., of Wallsend. The arrangement of the turbines was altered considerably from that of the *Turbinia* in order to get increased manœuvring power. Three shafts were still retained, with two screws on the wing shafts and one on the centre shaft, which revolved at rather lower speed; but, instead of all the three turbines being in series, the steam passed first through the centre high pressure one, and then was divided between two low pressure turbines, port and starboard. In the same casing as these low pressure turbines, and at the exhaust end, the stern turbines were incorporated. Such turbines are shown in Figs. 16 and 17. This gave much better manœuvring power than with the arrangement in the *Turbinia*, as when manœuvring the high pressure turbine was cut out and steam admitted direct to either or both of the low pressure turbines or to the stern turbines, thus giving as good manœuvring power as in the case of a twin-screw ship with reciprocating engines.

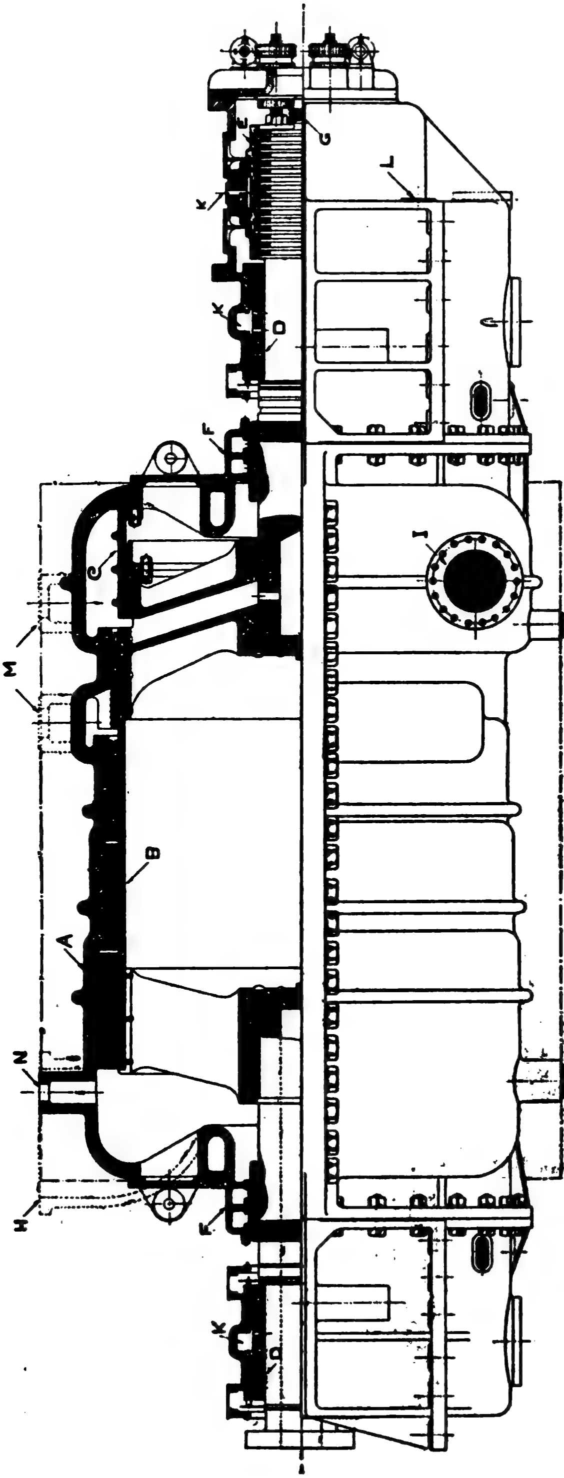
The success of the *King Edward* was the starting point for the success of the turbine in the Mercantile Marine for ships above about 18 knots, and it may be worth while to consider in what that success consisted.

At sea as well as on land one of the most important questions is coal consumption, and it was found by Messrs. Denny that this was some 20 per cent. less than in the case of similar vessels with reciprocating engines; also the cost of oil, which generally amounts to something like 5 per cent. of the coal bill, was reduced to well under 1 per cent., and at the same time the upkeep of the machinery was found to be very small, and it was most reliable. Vibration was also less, and the necessary engine-room staff much reduced.

The success of the *King Edward*, together with that of the *Viper* and *Cobra*, led the Admiralty to have turbines fitted into one of four third-class cruisers, and the vessel chosen was the *Amethyst*. Extensive trials were carried out between her and her sister ship, the *Topaz*, with reciprocating engines, each being 350 long and of 3,000 tons displacement. The turbine engines were similar to those described in the case of the *King Edward*, only cruising turbines were added to give better economy at low speeds, while the reciprocating engines were of the usual triple expansion, Admiralty type. The result was that at all speeds above 14 knots the turbine was the more economical, being 15 per cent. better at 18 knots, 31 per cent. better at 20½ knots, and 38 per cent. better at 22·1 knots. At full power on the same coal consumption the *Amethyst* with the turbine engines developed 42 per cent. more power than the *Topaz*, while on the specified coal consumption the speed was 23·6 knots, as against 21·1 knots, or 2½ knots more, representing an extra power of about 37 per cent. Another way of looking at the results is that at 20 knots the turbine ship has a radius of action of 3,600 nautical miles, while that with a reciprocator has only a radius of action of 2,000 nautical miles, or little more than half.

With cross-channel boats it has been found that the turbine vessels use 25 per cent. less coal per passenger and travel two knots faster than those with reciprocating engines, and the

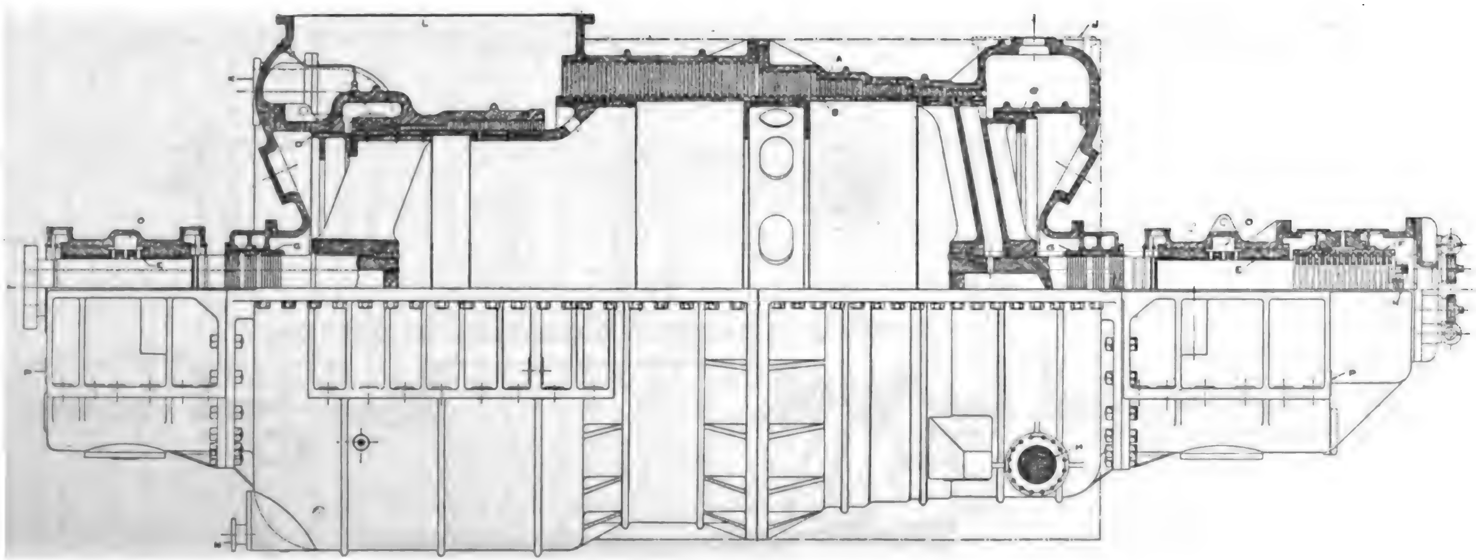
FIG. 16.



PLAN OF PARSONS HIGH-PRESSURE MARINE TURBINE. (Upper Half Sectional Elevation Lower Half External View.)

A, Cylinder. B, Rotor. C, Balance Piston. D, Bearing. E, Adjusting Block. F, Steam-Packed Glands. G, Worm for Actuating Governor. H, Exhaust to Low-pressure Turbine. I, Steam Inlet. J, Turbine Drain. K, Oil Inlet. L, Oil Drain. M, Bye-pass Connections. N, Boss for Relief Valve.

FIG 17.



PLAN OF PARSONS LOW-PRESSURE MARINE TURBINE. (Upper half sectional elevation. Lower half external view.)

A, Cylinder. B, Rotor. C, Ahead Balance Piston. D, Astern Balance Piston. E, Bearing. F, Adjusting Block. G, Steam-packed Gland. H, Worm for Actuating Governor. J, Low-pressure Turbine Steam Inlet from High-pressure Turbine. K, Astern Turbine Steam Inlet L, Exhaust to Condenser. M, Low-pressure Manœuvring Steam Inlet N, Turbine Drain. O, Oil Inlet. P, Oil Drain.

Lusitania has been shown by Sir William White to be 16 per cent. more efficient than the great German reciprocating liners.

Nineteen hundred and six was a notable year in the history of the Marine Steam Turbine, for in it two great events occurred—the Admiralty decided to fit turbines in all new fighting ships, and the Commission appointed to consider the question of the 25-knot Atlantic liners to be built by the Cunard Company decided on turbines instead of reciprocating engines for these great vessels.

The Admiralty went up from the 15,000 horse-power of the *Amethyst* to the 23,000 horse-power of the *Dreadnought* and the 41,000 horse-power of the *Indomitable*—a gradual rise, it is true, but a great one when one considers the large number of vessels involved and that it affected practically the whole shipbuilding programme of Great Britain.

The Cunard Commission went up from the 8,000 horse-power of the cross-channel boat *Queen* to the 70,000 horse-power of the *Mauretania* and *Lusitania* in a single step, a thing requiring the greatest courage and confidence on the part of the late Lord Inverclyde and the rest of the Cunard Company, for there was always the great danger of building another *Great Eastern*, and having a huge "white elephant," as Brunel had in the middle of the last century. How successful these ships have been has been proved by the recent trip of the *Mauretania*, in which she crossed the Atlantic in less than 4½ days at an average speed of just 26 knots.

In these Cunarders each low pressure turbine weighs about 300 tons, is some 50 feet in length and 17 feet 6 inches in diameter; in the *Queen* they were only 25 tons weight, 20 feet long, and 6 feet in diameter.

Such a departure necessitated the most careful consideration of the effect of expansion on the various parts and of the deflections due both to difference of temperature, stresses due to rolling and pitching at sea, and the weight of the structure, for in engineering there is more danger in going from a small structure to a large than in anything else, as stresses go up in all directions and the whole tends to become relatively less rigid.

In these vessels on account of their great size it was decided to have four shafts, both to reduce the size of the turbines and to give increased reliability in case of accident. Thus each side, port and starboard, is complete in itself, having a high pressure and a low pressure turbine on separate shafts, and to reduce the size of the low pressure turbine the arrangement in the *Turbinia* was reverted to of separate stern turbines fitted on the high pressure shafts, which in this instance were the wing ones.

How effective this was will be seen when it is remembered that when the *Mauretania* lost a screw in consequence of striking some wreckage in the Atlantic she was still enabled to run the rest of the season with one turbine out of action at a loss of speed of only about two knots, and when a further accident caused the loss of another screw she still was enabled to cross the Atlantic at a fair speed. This seems to be about the greatest test that the reliability of these great ships could be put to.

In the case of warships also, especially of large size, a similar arrangement of four shafts is adopted, and such an arrangement has the great advantage that each set of engines is completely independent of the other, and thus, although one may be disabled by gun fire or torpedo, the other is unaffected, a condition which it is not possible to arrange with three shafts as in the case of the *King Edward*, *Amethyst*, &c.

Some greater economy might be attained both in weights of the turbines, and in steam consumption, by having instead of two high pressure turbines, a high pressure and an intermediate, exhausting into two low pressure turbines as before; but the advantage thus gained is partly counterbalanced by the loss of complete independence of the two sets of engines, most necessary for manœuvring, and the complication in the pipe arrangement. However, such arrangements are likely to be adopted in many cases in the near future.

During the past twelve years, there has been a distinct improvement in the steam consumption of turbine ships.

In 1897 the *Turbinia*	consumed	16lbs.	per shaft h.p.
In 1901 the *King Edward*	,,	16lbs.	,,
In 1907 the *Lusitania*	,,	12lbs.	,,
In 1907 the *Mauretania*	,,	11½lbs.	,,

The last figure represents about 69 per cent. of the energy available in the steam, according to Rankine's Cycle, and it is worth considering both where the increase in economy has taken place, and what increase is possible in the future.

Part of the improvement is due to increased size, which as a rule under similar conditions, gives more economy, because of the reduction in the ratio of clearance to length of blade, an

consequent reduction of leakage. Part also has been due to improvements in manufacture and design, especially in the direction of better vacua. Increase in the steam pressure above, say 120 to 150 lbs. at the turbines, as a rule, improves the efficiency of the turbine only a little, and adds to the weight not only of the turbine, but also the boilers, steam pipes, &c. More can be done at the lower end of the range of expansion, that is, by improving the vacuum. In the first lecture, it was shown that between a vacuum of 25″ and 26″ or between 26″ and 27″ (barometer, 30 inches) there was a gain of about 4 per cent., between 27″ and 28″ 5 per cent., and between 28″ and 29″ 6 to 7 per cent., or that about 3° Fahr. difference in the condenser temperature, meant a gain of 1 per cent. In the improved condensers described before, the temperature difference between the water leaving the condenser and the steam may be as low as 5° or 6° Fahr., and this with such high rates of condensation as 12 to 14 lbs. per square foot; and it is in the direction of more generally adopting such types of condenser as give the highest vacuum that one source of extra economy is to be looked for.

Another direction is the introduction of superheated steam for marine work as well as land work, but here the practical difficulties have not up to the present been satisfactorily surmounted. It is, however, quite possible that with improved arrangements and materials these difficulties may be got over in the future.

The application of the steam turbine to the propulsion of slow-speed ships, that is, ships of below 15 to 18 knots, has up to the present been difficult owing to the low speed of revolution of the screws making the turbines large and heavy, as well as not economical. This difficulty has now been got over by the use of an arrangement patented by Mr. Parsons some years ago, viz., the combination of reciprocating engines and exhaust turbines, similar to what was described before for land work. Here each utilises the part of the expansion for which it is best suited—the reciprocating engine for the high pressure part of the range, and the turbine for the low pressure where the volume of steam is large. The reciprocating engine, as explained before, is not economical for low pressures and large volumes, and the steam turbine, especially when the rate of revolution is small, is large, heavy, and uneconomical for high pressures and small volumes; but the turbine for low pressures, even at low revolutions, is an exceedingly economical heat engine. Thus the combination is more economical than either alone.

Many arrangements are possible, but probably the best is to have twin reciprocating engines port and starboard as in an ordinary twin screw ship, both exhausting at somewhere about 9 or 10 lbs. absolute into a turbine, driving a centre shaft. Under these conditions, the power in each shaft is about equal, and for manœuvring, the reciprocating engines alone are used, just as in the ordinary three-shaft turbine arrangement the low pressure turbines are used.

The first ship to be fitted thus is the *Otaki*, built and engined by Messrs. Denny, who are again taking the lead, as they did in the case of the *King Edward*. She is of 8,000 tons displacement, and at 13 knots sea speed requires only 5,000 horse-power. With 200 lbs. pressure and without superheaters being fitted, the very low consumption of 12·3 lbs. steam per shaft horse-power for all purposes was attained on trials, and better results are expected after more experience is gained in the working of the ship. But even this trial consumption is better than that which could be attained by the use of either reciprocating engines or turbines alone.

It is interesting to note that in the early days of the screw propeller the great difficulty was to make the engines run fast enough for the screw, and spur gearing was adopted in many cases in the first half of the last century. Gearing has been entirely dropped for the last fifty or sixty years, but now the difficulty in many cases is to make the turbine run slow enough for the screw, and once more gearing is being considered so as to make the turbine adaptable for use in slow speed steamers which, after all, constitute by far the greater part of the shipping of the world.

The combination system described above does this, but gearing a high speed turbine to a slow speed screw would also accomplish what is needed.

Eighty years ago, there was nothing but primitive spur gearing, with generally wooden teeth in one member, but now we have steel gears accurately cut by modern machinery, often with helical teeth, and running in oil baths. Chain gears of some form are also promising, as well as various forms of electrical and hydraulic gear. The electrical gearing is especially promising, one or more turbines with dynamos or alternators, practically identical with those used on land, being employed to

drive one or more motors on the screw shafts at reduced speeds of revolution. Again, in the combination system of reciprocating engine and turbine, the exhaust turbine may be a high speed one, driving a motor on the shaft of the reciprocating engine instead of a screw on its own shaft.

Such questions are now receiving much attention, and may result in all the steamships of the world being wholly or partly turbine-driven, instead of only those vessels of comparatively high speed.

At the present date there are about 120 vessels actually on service fitted with turbines, representing about 1,250,000 horse-power, and these comprise practically all the high-speed ships which have been recently built. Some 70 more are under construction, representing another 1,000,000 horse-power, or a total of 2,250,000 horse-power, and the curve of progress as yet shows no sign of saturation.

And now I have given you a short review of the position of the steam turbine at present. What the future may bring forth it is difficult to say. It has taken 200 years to bring the reciprocating engine to its present high state of efficiency; the steam turbine in a practical form is only 25 years old, and already has in many instances proved its superiority to its older rival. What may be the motive power of the future it is difficult to say. At present coal and waterfalls are the two great sources of motive power in the world; a minor one is the force of the wind, but largely on account of its uncertainty it is only of small importance. Another is the heat of the sun, but the utilisation of this directly has not been made practical as yet. But it is from this heat of the sun that we derive the power in our coal; in fact, the energy of the coal is the power of bottled sunlight which shone thousands of years ago, and there is more truth than is generally thought in Dean Swift's idea in "Gulliver's Travels" of the Laputans bottling sunlight in cucumbers. This electric light above us is really the sunlight which fell on the forests of the coal period many thousands of years ago. In this country we have little water-power. But the process of using coal to produce steam, and this steam to drive an engine, is a very wasteful one. In the very best steam engines only about 12 per cent. of the energy of the coalis converted into work, the other 88 per cent. is wasted in the losses in the chimney, by radiation, from friction, and, above all, in the condenser. This last is inevitable, owing to what is known as the second law of thermo-dynamics: it would take too long to-night to explain how it is inevitable. Slightly greater efficiency can be obtained by gas engines, but up to the present practical difficulties have prevented their adoption on a large scale. One way to get over this difficulty would be to form a battery using coal instead of zinc, and to convert the energy of the coal directly into electricity without the intervention of boilers, steam engines, and dynamos. How to do this has, however, still to be determined. But, as pointed out by the late Professor George Fitzgerald, there is a great source of energy in the air around us, if we could only tap it, and turn it to the use of man. This could be done by the "Sorting Demon" pictured by Clerk Maxwell. The second law of thermo-dynamics is only true for masses of molecules, and it may be possible that in the future we may find some way of harnessing the quick-moving molecules of the air, and letting the slow-moving ones go by. If we found out some such apparatus, we should be able to utilise for the service of man the energy of the atmosphere without the consumption of coal or other fuel. And if we look back on the advance made in the last 100 years, who will say it is impossible? Fancy our great grandparents in the "Flying Scotchman" travelling at the rate of 60 miles an hour. What would they think when a telephone was put to their ears, or a gramophone was set going? What would be the effect on a stage coach if it met a bicycle or a motor car? Still more, if an aeroplane arrived? Some of these things would have been declared impossible even within the memory of many of those here present.

SOME SPECIAL FEATURES OF THE DANISH SYSTEM OF CATTLE BREEDING.*

Denmark, mainly an agricultural country which formerly grew corn for export and raised very few cattle, began to turn its attention to dairy farming after the middle of last century. With the introduction of the centrifugal cream-separator and the building of co-operative dairy factories all over the country in the eighties the system of dairy farming spread to even the smallest farms. The question of improving the two national milking breeds, the black and white Jutland and the red Danish dairy cattle, became important and of interest to almost all farmers.

* Abstract of a paper read by Peter A. Mörkeberg before the Agricultural Sub-Section of the British Association, at Winnipeg, 1909.

The work of improving cattle breeding in Denmark being, as explained, of fairly recent date, has been gradually developed in two quite distinct directions; some features of the work aim at encouraging prominent breeders to develop herds capable of transmitting the most valuable qualities of the breed and inducing other breeders to take up this work, while other features aim at the better utilisation of the breeding animals from these superior herds for the improvement of the cattle breeding in general.

For the first purpose cattle shows and "selection of breeding centres" have been found useful, while Cattle Breeders Associations and Control Unions have helped in the other direction.

Cattle shows began about the middle of last century. At first all breeds and crosses competed together; from the sixties there were separate classes for the different breeds.

Already about the year 1870 the classes for single cows were discontinued and prizes offered instead for collections of cows bred by the exhibitor, a feature which is still considered very important, the idea being to draw attention to the best herds, which can more safely be done when a collection and not a single individual is shown. In 1887 the State caused to be held special shows for bulls over three years old for the purpose of encouraging farmers to keep the good bulls for a longer time. The result has been striking, the number of old bulls shown having increased from 371 to over 1,200. A special Danish feature has been introduced with these shows, viz., judging the bulls through their offspring, inasmuch as no prize is awarded for bulls over five years old unless their offspring, which must be judged before the show, have been found satisfactory. This entails a good deal of work, but has been found very useful.

The judges at shows take into consideration not only the points of the exhibited animal but also, in the case of bulls, the pedigree, including information of the milk production of the dam, and in the case of cows the milk production (quantity and quality).

Selection of breeding centres, that is a systematic selection of the best herds, which then receive an official recognition as "Breeding Centres," is another special Danish feature introduced in 1894. The herds are entered for a competition which is carried on during two whole years by a committee of judges, who visit the herds on the farms five or six times, while assistants on every twentieth day during the two years visit each of the competing herds, weigh the milk of each cow, test its percentage of fat, weigh the fodder given to each cow, and draw up the family herd book, in which the whole herd is arranged according to maternal descent, each animal being described with its sire and dam, milk production and prizes. At the end of two years' testing the committee of judges have acquired reliable information as to the value for use and for breeding of the different herds. The best herds are then designated as "Breeding Centres," with the result that the demand is increased for breeding animals from these herds at enhanced prices. A full report of the result of the two years' competition is published.

The Cattle Breeders' Associations have for their principal aim the purchase of a good bull. The first Association was formed in 1883. From the first these Associations paid attention also to the cows and to the health of the herds; they required also accounts kept of the feeding and the yield of the individual cows. From 1887 the State gave a yearly grant which helped the movement on. There are now 1,300 Cattle Breeders' Associations with 1,500 bulls, the State giving £8 per annum per bull on condition that the bulls have taken prizes, that the committee select the best cows of the members to be served by the bull, and that the committee at least once a year inspect the herds on the farms as to the state of health.

While the other objects of the Cattle Breeders' Association have been attained it was different with the required accounts of the feeding and yield of the individual cows. The members could not manage these, and when in the beginning of the nineties information of the percentage of fat in the milk was included in the requirements it was found necessary to take this whole matter up in a different way. This led to the formation of the Control Union of Cow Testing Associations. The object of these is to strike a balance-sheet for each individual cow for the guidance of the daily feeding, for the weeding out of those cows which it does not pay to keep, and for the selection of cows for breeding. Farmers in a district appoint jointly a "controlling assistant," who once every fourteen or twenty days visits each herd, weighs the milk of each cow, estimates the percentage of fat, weighs the food given daily to each cow, and keeps account of it all. He further keeps a book of the serving and calving, with all information necessary for the family herd book. The first Control Union was formed in 1895; now there are 479, with 10,925 members and 187,345 cows, comprising over 17 per cent. of the total number of cows in the kingdom. The work is carried on by 500 controlling assistants, the State giving a grant of £14 per union yearly.

The information with regard to the yield and quality of milk of the individual cows collected by the Control Unions is taken into account in awarding the prizes at the shows, and is also made use of in selecting the cows to be served by the bulls of the Cattle Breeders' Associations.

THE LUNACY REPORT.

The report of the Commissioners in Lunacy, just issued, shows that the figures for lunacy continue to rise somewhat rapidly. The last ten years show an increase in the general population of 12·1 per cent.,

while the insane have increased 22·5 per cent. On January 1, 1909, there were known to be under care in England and Wales 128,787 persons certified as insane, a number which exceeds by 2,703 that recorded on the 1st January, 1908. The average annual increase for the ten years ended December 31, 1908, was 2,370, and that for the five years ended on the same date 2,317; or, to put it in another way, on the 1st January, 1909, the total number of notified insane persons in England and Wales stood to the estimated population in the proportion of 1 to 278, or 36·02 per 10,000. This gives an increase on the ratio of the preceding year of 0·98 per cent., whilst the actual numerical increase has been 2·1 per cent. On the 1st January, 1899, this ratio was 32·96, so that in the ten years it has increased by 9·2 per cent., the proportion of such insane persons, in the community having risen from 1 to 303 to 1 to 278. No doubt, increasing thoroughness of notification has something to do with the increase. Influenza too, a comparatively new scourge, has played its part, more especially if it has induced any large proportion of the heart troubles by which mental defect is so often accompanied. Urban life, with its temptations and strains on the nervous system, accounts too for a part of the increase, and drink, which is not one of the largest factors in female lunacy, accounts for 24 per cent. of the male pauper lunatics. The increases in lunacy show a decided tendency to be in urban rather than rural counties, and in the larger rather than the smaller boroughs, Manchester heading the list in this respect. There also appears to be a high ratio of insanity in nearly all the professions (except that of teachers) where the work is mental. For example, the ratio for clergymen is 10·7, medical practitioners 14·2, literary and scientific persons 19·4; civil and mining engineers 49·8; artists, engravers and sculptors 25·4; architects 23·2.

For many years past the Commissioners have, at intervals, indicated the great importance they attach to the early and individualised treatment of insanity as affording prospects of recovery with which the results of subsequent efforts are quite unable to compare, and it is possible that many people lose their reason who would not do so if they could be detained and appropriately treated at an earlier stage of their affliction. The Commissioners urge the need for the removal of some of the difficulties which attend certification and which, as they say, lead to constant infractions or evasions of the law, and to such delay in treatment as is frequently disastrous. They recommend that if a medical practioner certified that a person was suffering from mental disease, but that the disease was not confirmed, and that it was expedient with a view to his recovery that he should be placed under the care of a person whose name and address should be stated in the certificate for a period therein specified not exceeding six months, then during that period the provisions of Section 315 of the Lunacy Act, 1890 (which makes it illegal to receive or detain a lunatic, or alleged lunatic, in an institution, or in an unlicensed house, except under the provisions of the Act and the order of a judicial authority) should not apply. The Commissioners support their recommendation by the example of Scotland, where the treatment of incipient insanity, in the manner they suggest, is lawful, and works as well, but it may be expected that Parliament will examine very narrowly any proposals that might have the effect of lessening the safeguards against improper arrest and detention. The Commissioners support the far-reaching proposals submitted a year ago by the Royal Commission on the feeble-minded. It may be remembered that they relate to a better and fuller classification of cases; the extension of treatment to kinds of mental defect at present unduly neglected, and the withdrawal of the whole matter from the Poor-law authorities, which means, practically, the abolition of "pauper lunatics."

THE USE OF CAMELS FOR TRANSPORT IN TURKEY.

There is no scientific system of camel breeding in Smyrna, and now they are only to be found in the villages of the ancient nomads or Yuruks, who are numerous in every part of the country. The nomads make a living for the most part in transporting merchandise from one part of the country to another where there are no railway communications. The dromedary is the chief beast of burden, but, for some unexplained reason, the number is diminishing from year to year. The American Consul-General at Smyrna says that there exist at present three varieties of the dromedary. The first variety is distinguished by the long hair of the mane, and more especially by the length of the hair of the shoulders and neck in the winter time; the second has light curly hair on the mane, neck, and shoulders; the hair of the third is perfectly smooth, and this variety is chiefly found in the mountain districts of Asia Minor. These varieties are obtained from cross-breeding with the two-humped camel, which certain proprietors bring from the district of Konia and Angora every winter, and the females of the second and third varieties. The food of camels and dromedaries in the district of Smyrna, from the month of September to March, consists of straw and beans, which are moistened, pounded, and kneaded before being given to them each evening. From the month of March onwards, and during the extreme heat of the summer, they live chiefly on hay and grass. The Yuruks of the highland district plant grain and valonia acorns in fields where camels have pastured for a season. The prices of dromedaries are as follows:—First variety, £18 to £23; second variety, £14 to £18; third variety, £11 to £14. Dromedaries are used principally for transporting merchandise such as cereals, valonia, figs, emery stone, licorice root,

&c., and in this capacity they are indispensable. As many as a hundred are sometimes seen, led by a little donkey, each laden with the products of the interior of Asia Minor, and all bound for Smyrna, the nearest seaport. In Smyrna itself they are so numerous sometimes in the streets of the city that they block the traffic. In the rough mountain districts they are much more useful than horses and donkeys, especially in many districts where there are no country roads, while, at the same time, they can carry much greater loads to market. Then, again, the cost of maintenance is very much less than that of any other beast of burden. The third variety is especially adapted for hilly country, and this is one reason, perhaps, why only this breed is to be found among the villages situated in the mountains. At the age of three they are broken to loads, but it is only at the age of five or six that they can do the maximum of the work devolving upon them. The strength ol a camel begins to decline at the age of twenty, as the average life of the toughest breed is only about twenty-five years. The best species come from the villages situated in the plains, and those of the Meander Valley are preferred to those of the Hermus. The cost of maintenance depends a good deal upon the liberality of the proprietors. Among the Yuruks, who inhabit the high mountain districts, their keep amounts to practically nothing. The cost of keeping a camel, however, in the Menemen plain, near Smyrna—during the winter months only—that is about four months' stabling, may be estimated at £5. The ordinary caravans consist usually of seven camels, and experience has shown that this is all that can be conveniently entrusted to one driver. The price for transportation varies according to the locality and the amount of work, but the average cost of a camel will come to about two shillings a day. In Smyrna, one Turkish merchant owns about 400 camels. Throughout Asia Minor, camels or dromedaries are used only as beasts of burden, while in Syria many are broken to the saddle and used as riding animals across the deserts. Upon the great caravan route between Trebizond, on the shores of the Black Sea, and Tabriz, in the heart of Persia, hundreds of loaded camels in a single drove may sometimes be seen. While, as time passes, the camel will not be able to stand the keen competition of the new railways, which are piercing every part of Asia Minor, yet, thanks to the power of tradition over the Turkish inhabitants of the country and the fondness for these animals, the caravan routes of to-day are still able to hold their own side by side with the Anatolia, Cassaba, and Aidin railways. Hundreds of camels pass over the caravan bridge into the city of Smyrna every day, and in the market place in front of the mosque of Mohammed, at Constantinople, many camels may still be seen. As far back as the middle of last century, General Von Moltke, in his descriptive letters from Asia Minor, had many good words to say about the camel. "This animal," he said, "can carry a burden of nearly six hundred pounds, and is used by the nomads and Arabs in taking their women, children, old men, tents, food, water, &c., from place to place. It is able to withstand a march of ten days without drink. The hair of the camel is used for clothing and tents. The milk and flesh are healthy. It exists on the most miserable food, such as grass and thistles. Such are the characteristics of this patient, strong, and most useful of animals." A camel is never relieved of its load from the beginning of the journey to the end. It eats, walks, and sleeps under its burden, often for weeks at a time. The training of a camel is no easy matter, as it takes about three years to teach it to bend the knees in order to be loaded and unloaded.

THE DEVELOPMENT OF SICILY.

The future of Messina is still a matter of uncertainty, according to the new Consular Report on Sicily, but circumstances make it probable that in a few years it will regain its former importance, though for the time being there will be a tendency for the trade of the eastern side of the island to diverge to Catania and Syracuse. From the point of view of the inhabitants of Palermo it would be very disastrous if the extinction of Messina were of long duration, owing to the connection and close communications that have so long subsisted between the two cities. Arrangements had been made for the construction in the earlier part of the year 1908 of two large and improved ferry-boats between Messina and Reggio di Calabria on the mainland. The main object of these new boats was to permit of a *train de luxe* crossing the Straits on one boat instead of on two, with the consequent division of the train into two portions, as heretofore. The new boats were designed to attain a speed of thirteen miles an hour; they were to be built at Naples and Leghorn, and to cost £80,000, but the calamitous consequences of the earthquake have ruined these and other projected improvements. Another enterprise which appears to have been suspended or postponed, if not actually put an end to, was the inauguration in January last of a fast service from Messina to Egypt by means of well-appointed steamers of 12,000 tons. The voyage from Messina to Alexandria was to have occupied only forty hours. Although there were numerous openings for British trade with Messina, especially in tissues, such as woollen, muslin, cotton goods and apparel, implements, boots, &c., it is surprising to read that only one commercial traveller called at the British Vice-Consulate during 1908. The most important British import into Sicily is coal, of which 642,185 tons were conveyed thither in 1908, this being a considerable increase on the figures of the previous year. Among the more important exports from Sicily it is worth noting that the check sustained by the sulphur industry in 1906, owing to vigorous competition by

American produced sulphur, continued in 1907 and 1908. The exports are believed to have diminished, and there is without doubt an accumulation of stocks and over-production, into which a Government Commission is at present inquiring. Wine, another interesting Sicilian product, has commanded very low prices, as much of the 1907 wine was still unsold at the time of the vintage. Nevertheless the yield in 1908 was above the average. It would have been still larger had the year not been exceptionally dry, but the absence of rain during the vintage and the comparative coolness of the summer, combined to produce a wine of very good quality and of greater alcoholic strength.

ARTS AND CRAFTS.

The Lace Exhibition at the Mansion House.—Lovers of hand-made lace had a real treat last year in the Exhibition held at the Horticultural Hall. The little show at the Mansion House last week was, of course, on a much smaller scale, and a good many of the exhibitors complained of the limited space at their disposal; but quite enough was shewn to prove the vitality of the hand-made lace industry in this country. Moreover, the leaflets circulated in the Exhibition by the newly-formed "National Association for the Organisation of the Hand-made Lace Industry in England" made it plain that those interested in the maintenance of English lace-making and the well-being, both of the industry and of the workers, are combining in the hope of improving the quality alike of design and workmanship.

In the desire to give employment to people in country villages and to dispose of the lace made by them, a certain amount of work has been encouraged which is by no means as good as it ought to be. The more far-sighted of those in the revival and the continuance of lace-making in this country realise that the prosperity of their industry, and of the workers engaged in it, will be furthered, not by doing cheap lace, which might almost as well be turned out by the machine, but by encouraging the competent execution of good designs. In lace-making, as in other trades, it is the really skilled worker in the finer kinds of work who earns the best wages. It is also the fine lace, which no machine can successfully imitate, which can count on a steady market at a good price; and good workmanship is wasted upon a worthless design. It is, therefore, to be hoped that the effort to raise the level of taste and technique will meet with that success which it certainly deserves.

The general standard at the Mansion House was high. There was some coarse lace made on the lines of Italian and Austrian work which was very pleasing in effect, and some of the Buckingham lace was very good. But the most interesting exhibits, on the whole, were those from Devonshire. The little case of work exhibited by students of classes held under the Devon County Council included one very fine specimen of Honiton, and several other pieces which as the work of pupils who had only been under tuition for fifteen months and did not come from districts with a strong lace-making tradition, were quite remarkable. The people responsible for the North Devon Cottage Industry have had the happy thought of going back behind the regular Honiton tradition, and reviving the older Devonshire lace with its more conventional design and somewhat different treatment. The majority of the lace designs sent in were rather disappointing. Some were eminently fit for their purpose and others were quite satisfactory as patterns, but they were seldom good in both respects.

The Schools.—It has become the custom in the London Art Schools to hold an exhibition of students' work just before the beginning of the school year, which opens with the autumn session. At the large schools these shows are, of course, confined to the work of present pupils, while at the smaller ones a considerable space is sometimes allotted to the work of former students now earning, or trying to earn, their living by their skill. It is, not unnaturally, somewhat of a disappointment, after going carefully through the National Competition show, where the exhibits are not merely the pick of the work sent from the schools all over the country, but the pick of that, to turn to the productions of the local schools one by one and to see how very much higher is the level of accomplishment required for success in National Competition than the attainments of the ordinary average student. Indeed it is difficult to get the higher standard out of one's head and to judge the work of the individual schools quite fairly. For all that these smaller and less attractive shows fulfil a very useful purpose and ought to be of the greatest interest to the student. Nothing is easier to the would-be student than to go round an exhibition of works gaining awards in National Competition and to imagine that in a year or two's time he will inevitably, since of course he is a very clever fellow, be doing work as good as what he sees there. If, however, after his visit to South Kensington, he goes to see the exhibition at a local school of art he will realize, unless he is singularly wanting in intelligence or suffers from inordinate self-satisfaction, that it is by no means so easy as he fondly imagined to do really good work as a designer and a craftsman, and that there are a very large number of serious students who never arrive at doing anything like first-class work. No one wants to depress students unduly at the beginning of their career, but they are far more likely to be permanently depressed if they start with the idea that they are going to do wonders than if their ambitions at the outset are more modest.

Some Recent Lustre Pottery.—It is not at all surprising that in a scientific age some of the most successful artistic achievements should be in crafts and manufactures where chemical experiment plays a very important part. Artists and men of science do not always understand each other very well; but the

man of science whose researches enable him to produce something really beautiful is, they must admit, a very good friend to art. The branch of industry in which art and science have of late years walked most peacefully hand in hand is perhaps pottery manufacture. It cannot, of course, be contended that any very large proportion of the output of the pottery trade in this or any other country is really artistic; but there is no doubt that the direct outcome of increased chemical knowledge has been the production of beautiful wares, some of which, like the various types of crystalline glazes, are really new, whilst others, like lustre, are the revival of an art that was long lost. The sort of boom in crystalline glazes which followed the last Paris Exhibition seems for the moment to have come to an end. It appealed apparently only to a very limited public. There is, indeed, some very charming work being done in these kinds of glazes, but the attention of manufacturers seems just now to be directed rather towards lustre. There are several firms making lustre ware of various kinds, but the exhibit of the Pilkington Tile and Pottery Company at the Franco-British Exhibition last year, which included a large show of painted lustre, marked a very definite step forward in the development of lustre painting. It is one thing to get lustrous effects of one sort or another; it is a very different and much more uncommon achievement to paint in lustre patterns and figures which, with all the wealth of ever-changing colour, are clearly and precisely drawn. It is therefore very interesting to see that, instead of resting content with what was accomplished last year, the firm has been still further developing this kind of work. Not only have they increased their range of colours—some of the deep strong blues now being made are really fine, and the delicacy and brightness of the newest green is quite wonderful—but they have had, further, the happy idea of painting a thin coat of slip under the glaze which strangely changes the whole quality of the colour. Sometimes the inner surface of a bowl is completely coated with slip while the outer surface is glazed in the ordinary way, and this results in a very pleasing contrast of effect. An equally pleasant contrast on the outer surface of a vessel is obtained by coating only the neck or some prominent portion of the ornament. The under-coating of slip, without taking from the lustrous effect, adds considerably to its delicacy, and it produces always a very subtle variety in the quality of the colour.

In the direction of modelling in combination with lustre a good deal has been done in the last year. One of the largest recent pots is enriched with a St. George and the Dragon in comparatively high relief, whilst some of the vases have bulbous necks decorated with modelled ornament, and higher relief than heretofore is used in some of the tiles. It is, no doubt, very easy to overdo relief in pottery. If the artist does not exercise a good deal of self-restraint, his work may get lumpy and coarse before he is aware of it, but of the suitability of a modelled surface to the display of lustre colour there can be no manner of doubt. For one thing the glaze, melting as it does in the fire, runs off the parts in high relief and collects in little pools, as it were, in the background, which leads to an astonishing variation in the depth of the colour. Then, the unevenness of the surface, which catches the light at all sorts of angles, not only enhances the effect of the lustre, but adds greatly to the variety of its tone. There may be room for objection to modelling on vases on the ground that, modest as it may be in its early stages, it will probably end in excess; but the objection could hardly be urged by the most bigoted critic with regard to tiles, whilst it would be difficult to imagine more beautful colour than that produced by the play of the firelight on modelled lustre tiles.

EMPIRE NOTES.

Steel Smelting in Vancouver.—A striking illustration of the need of alertness on the part of British capitalists is afforded by the statement that a United States firm—the Irondale Steel Company, of Washington—proposes to locate on a site to be selected somewhere in the Province of British Columbia a plant which will employ not less than 1,500 men. The company looks for a subsidy from the Government of the Province which is likely to be granted, as, according to Mr. A. T. Frampton, who writes from Victoria, British Columbia, there is an exceptional opportunity for the establishment of an industry of this character in Vancouver Island where iron ore, coke, and the necessary fluxes are obtainable. He says that the authorities of Victoria have done their best to point out the unique advantages likely to attend the starting of an industrial enterprise of this nature, and have in vain sought to obtain the support of capitalists from the Mother Country for the purpose. Now the opportunity will be lost to them to the profit of our American cousins.

The Powell Wood-Process in New Zealand.—This wood seasoning process which consists of boiling timber in a saccharine solution, and then passing it into specially constructed drying chambers is about to be installed at Raugatana in New Zealand. The inventor of the process is Mr. William Powell, formerly of Liverpool, who, some years ago, noticing that timber used for flooring or wall plates in sugar factories never appeared to be affected by dry rot, made a number of experiments, which led him to conclude that wood boiled in a solution of molasses and water, and carefully kiln-dried afterwards, could be seasoned rapidly without splitting or cracking, and, with the addition of other ingredients, might be rendered immune to the action not only of dry rot but of white ants and the teredo, or sea worm. The process does not appear, at present, to have "caught on" in England, but in Australia and India works have been installed, and now the New Zealand timber people

have taken up the matter. As there appears to be value in the process it is surprising that it has not been adopted for rapid seasoning, and for rendering timber immune against dry rot, in this country.

The Federalisation of Australian State Debts.—This important proposal, which had been decided upon by the Prime Minister of the Commonwealth and the Premiers of the various States, at their recent conference in Hobart, has been submitted in the form of a Bill to the Commonwealth Parliament. The Bill provides for a Referendum on the subject, which will probably be submitted to the electors at the Federal elections in March next. The present State debts amount to £247,974,624. To this amount a few millions will have to be added, to cover financial obligations incurred since June 30th, 1908, bringing the total up to about £250,000,000 sterling. While this proposal will not interfere with the rights of the States or the municipalities to borrow on such security as they can offer, for railway construction and other reproductive and public works, some restrictions will, no doubt, be imposed as to the amount of such loans. It is, however, confidently expected that a considerable saving will be effected in the way of interest, which at present entails an annual charge of £8,839,695 upon the various States. This, one of the most important steps towards federation which has been taken by the Commonwealth and States Governments, should not only be to the commercial and financial advantage of the Commonwealth, but should lead to greater unity of action in all federal matters.

Trade Movements in South Africa.—Official statistics from Natal show that instead of an anticipated deficit there has been for 1908 a small surplus, which, in view of the recent lean years, is regarded as a favourable sign of improving financial conditions. The shipping returns are nearly up to those of the best shipping year (1905). The imports and exports, however, show a reduction, but there has been a considerable increase in land under cultivation and in the stock held by farmers. In the Transvaal, the revenue shows a large increase upon the previous year, while the amount of trade in tonnage, according to the report of the Chairman of the Board of Trade at Johannesburg, has increased in round numbers 9,000 tons a month during the six months ending June 30th of this year, as against 8,000 tons in the previous six months. There was also a satisfactory increase in the tonnage of goods in the Orange River Colony, while the imports in the Transvaal had increased to the amount of a million sterling, and the exports to over £700,000.

Gold Mining in Victoria.—The reduction of the cost of cyaniding from 10s. or 12s. per ton to 2s. opens a wide field for treating the low grade bodies of quartz and the alluvial sediments in Victoria. In a report of the State Director of Geology, he says that, in the stilt or tailings of the gold ore treated in Victoria, there is as much impalpably fine gold left as all the alluvial gold hitherto won. This is a striking statement in view of the fact that since the gold discovery of 1851, Victoria has produced over 66 million ounces, of the value of more than 282 millions sterling. There is no doubt, however, that the application of this process on a large scale will yield immense results in all the gold fields of Australasia. There are numbers of low grade mines in Western Australia, for example, which might be made to yield considerable returns were sufficient capital forthcoming to apply the economic methods of treatment now in vogue, notwithstanding the difficulties arising from the scarcity of water in the dry areas in which they are located. Here again is a great opening for the profitable investment of British capital.

Military Pensioners and Emigration.—In two recent articles in the *Pall Mall Gazette* the subject of the suitability of military men for emigration and of the opportunity afforded to pensioned non-commissioned officers to commute a considerable part of their pensions for this purpose, has been very ably treated. For purposes of defence as well as settlement it seems very desirable that many ex-soldiers, who, at present, find it difficult, if not impossible, to obtain work in England, should be encouraged to emigrate to the oversea dominions of the Crown, where they and their families might find new homes under conditions far more favourable than are possible here. According to these articles, a movement is on foot to get the War Department to extend the concession of commutation to private soldiers whose pensions only average 1s. or 1s. 1d. per day. At present, the Army Regulations require pensioners to leave 1s. at least of their pension uncommuted, which debars thousands of men, many of whom would gladly avail themselves of the opportunity of settling in our Colonies, from securing even a partial commutation of their pensions. Attention is also drawn to the fact that the Government scale of commutation is lower than the commercial value of such pensions; a fact which requires attention if we desire to do justice to men who deserve well of their country and who, in re-entering civil life, should be afforded every facility to make a good start for themselves and their families.

Colonial Exhibitions and their Uses.—In the address of Mr. Justice Longley at the inauguration of the Provincial Exhibition in Halifax, Nova Scotia, he claimed that that Exhibition had had "an immensely stimulating influence upon the agricultural and industrial life of the province." The Exhibition was designed to demonstrate the great variety of the resources of Novia Scotia—agricultural, horticultural, mining, and fishing—and its object appears to have been realised. Special mention is made of the display of fruit which was much commended, and of the root, and green crops which were far ahead of previous

years. There is no doubt that such Exhibitions help to awaken local interest and to arouse a spirit of emulation, especially among exhibitors of agricultural produce, which must make for the good of the country. At the same time, in the interests of our home trade, it is most desirable that the British manufacturer should be well represented at Exhibitions of this character held in the leading industrial and commercial centres of our Empire.

CORRESPONDENCE.

EARLY STEAM NAVIGATION.

In the note in last week's *Journal* on Early Steam Navigation, it was stated that Henry Bell obtained information *from* Fulton, but that no authority was given by Galloway for the statement. "From" is a misprint for "for." The authority for this statement is to be found in a letter by Bell, addressed to *The Caledonian Mercury* in 1816, and quoted by Woodcroft. From this it appears that Fulton had requested Bell to call on Miller, and obtain a drawing and description of his boat. This he did, and Bell adds that two years later (which would presumably be about 1790 or a little later) he heard from Fulton that he had constructed a steamboat, which seemed likely to answer, but required improvement. Bell goes on to remark that his correspondence with Fulton led him to think that it was absurd for him to send information abroad, and not to put his knowledge into practice in his own country, and it was this consideration which induced him to set about the construction of the *Comet*. Fulton therefore had a share in the introduction of steam navigation in Europe as well as in America.

After this Fulton came over to England, and in 1801 he was present at some of Symington's experiments, and was actually carried for some distance in the *Charlotte Dundas*. An objection made by Symington that the progress of the boat was impeded by the narrowness of the canal was answered by Fulton that the objection would not apply to the large rivers of North America, and this of course proved to be the case.

Mention ought perhaps to have been made last week of the Marquis de Jouffroy, who, in 1783, experimented with a boat at Lyons in which motion was communicated from a steam-engine by ratchet gear to a paddle-wheel. This was probably the first vessel ever moved on the water by steam.

H. T. W.

GENERAL NOTES.

WOMEN MEMBERS OF THE SOCIETY.—It may be interesting to note that ever since the foundation of the Society there have been some lady members. The earliest list in the possession of the Society (1756) contains the names of two ladies—Lady Betty Germain and Miss Elizabeth Vaughan. The Countess of Denbigh's name is added in 1758, and those of the Countesses of Macclesfield and Northumberland in 1764. Since that early date there have been very many women members, and their number is now considerable.

THE MALAGA RAISIN INDUSTRY.—In his report on the trade of Malaga, just issued, Mr. Cecil Staniforth directs attention to the export trade in raisins, and makes some remarks to which the attention of buyers in this country may be usefully directed. Owing to the low price which continued throughout the last vintage, farmers generally complained bitterly, so much so in fact that many who had large tracts of land in the best situations in the Guadalhorce Valley (which yields the best quality of fruit for the British market) have decided that their interests will be better served by planting beetroot, and are going to uproot their fine old muscatel vines. The root of the evil, says the Consul, lies in the fact that the principal markets of the United Kingdom refrain from buying at the commencement of each season, thus forcing the poorer farmers to send their fruit on consignment to London, and when once this market holds large stocks, the fruit is sold by auction at disastrous prices for the local farmer. There is every indication that if this course of events is annually repeated the Malaga raisin industry will, before many years, become a thing of the past. The total yield last year was about 900,000 boxes, or about a quarter more than was expected.

OPIUM IN CHINA.—It will be remembered that the Indian Government, in pursuance of its declared intentions, has been reducing the amount of opium offered for sale in India by about 5,000 chests annually, so that the amount put up for auction in 1909 will be 43,200 chests instead of 52,800 in 1907. But it may be gathered from Mr. O. R. Coates' report on the trade of Shanghai, just issued (Annual Series, No. 4360), that there has not been any appreciable decrease of native opium placed on the market. In fact, the amount of opium brought to Shanghai has been unusually large. In 1906 the gross amount of foreign opium imported into Shanghai was 33,219 cwt., and of native opium 15,731 cwt.; in 1908 the imports of foreign opium fell to 28,869 cwt., and the amount of native opium increased to 22,814 cwt. gross. A succession of Imperial decrees spurred the provincial governments to energetic efforts to suppress the opium habit, and among other measures the establishment of official monopolies for the sale of the drug, native and foreign, has been one of the most favoured. This form of restriction was obviously contrary to the treaties, and has been strenuously and successfully opposed by foreign dealers in the drug, but the attempt has had a disturbing effect on the trade, native dealers not daring to invest in large stocks of opium lest some arbitrary action of the local authorities should suddenly involve them in loss.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

AERIAL FLIGHT.

By F. W. Lanchester.

Lecture I.—Delivered April 26th, 1909.

The engineer, accustomed to dealing with problems in locomotion or traction, when confronted with the proposition of mechanical flight, will ask as his first question, "What is the magnitude of the coefficient of resistance, and on what factors does it depend?" In other words, "What is the force necessary to maintain a flying machine of given weight in a state of uniform horizontal motion?" It is only within the last few years that it has been possible to give an authoritative reply to this question, and even to-day we do not know with certainty what is the lowest obtainable limit. The coefficient of resistance or traction not only tells us what force is required to maintain a given body in motion, but as an immediate consequence it tells us the energy required to effect the transference of the body from one stated place to another stated place, since energy is force multiplied by distance, and, therefore, other things being equal, the coefficient of traction is the measure of the cost of traction.

In the first place a few facts will be given as to the resistance that obtains in other modes of locomotion, in comparison with that of some of the existing successful flying machines.

The resistance of an iron tyre over a common road varies ordinarily between 2 per cent. and 3½ per cent. of the load, depending upon the kind of road surface and its condition; the figure is much the same if solid india-rubber be substituted for the bare iron. If the pneumatic tyre is employed the tractive effort depends less upon the nature and condition of the road surface; it is usually about 2 per cent. to 2½ per cent. For a passenger train on rails the coefficient is commonly less than 1 per cent., being in some exceptional cases (at low and moderate speeds) as low as ·25 per cent. For ocean-going vessels the figures are much the same as for vehicles on rails. Thus the *Lucania* at full speed has a coefficient of ·7 per cent., and the figure for slow cargo vessels varies from about ·25 per cent. even down to ·1 per cent., the latter being the coefficient for a slow "tramp" steamer of large size.

Against the above figures the coefficient in the case of the Voisin flying machine is 13 per cent. or 14 per cent., and for the Wright machine 12 per cent. or thereabouts; thus in flight, if we may judge by existing practice, the resistance is at least four times as great as in any commercially established mode of locomotion, and is 20 or 30 times as great (or even more) as in transport by rail. These figures are given concisely in Table I, p. 1006.

It is evident from the foregoing that the power required to drive a flying machine at any given speed is far in excess of that required in any "commercial" mode of locomotion, and may be roughly represented as equivalent to driving an automobile up a gradient of at least 1 in 10. In view of the fact that for divers reasons (to be discussed later*) it is imperative that the velocity of flight should be at least in the neighbourhood of 30 or 40 miles per hour, it becomes evident that the problem of supplying the necessary horse-power is one of a very serious kind; in fact, it is *the* problem ever confronting the designer of the flying machine.

Professor Langley, of Washington, stated, some 18 years ago, that the power required for flight is less at high than at low speeds. This conclusion was given as a result of certain experiments, and it was for a considerable time very generally accepted, being termed

* Lecture II.

"Langley's law," though by what right it is not clear, since a law should be a quantitative and not a mere qualitative statement, and since the same view had already been expressed by Wenham.

Unfortunately, the optimistic view propounded by Langley in his so-called law has not been realised; in fact, it has no actual justification. It is founded on the supposed negligibility of skin-friction, a supposition that can be no longer upheld.

As a matter of fact, the power required for flight increases when the velocity is increased, and experiment and theory both indicate that the power and the velocity increase in approximately the same ratio. In the present lecture I propose to demonstrate the real relations that exist between power expenditure and velocity, and to point out the factors that impose a limit on the performance of the flying machine of the future.

In the first place let us turn our attention to the evidence of the hard facts with which we are acquainted. I have here a model, No. 1, of ½ gram weight, designed to fly at the very low velocity of five feet per second, and it will be observed that the gliding angle is approximately one in five, that is to say, the rate of descent is, roughly, one foot per second.

Now the work done by gravity in overcoming the resistance to flight is measured by this rate of descent, and since one horse-power is represented by the descent of a mass of 550 lbs. at one foot per second, the performance of this model is equivalent to a rate of 550 lbs. (sustained in flight) per horse-power expended. Putting this another way, if we had 550 lbs. weight of models identical with the present sample, they would require collectively a tow rope pull of 110 lbs. to maintain them in horizontal flight, which at five feet per second means 550 feet per pounds-second, or one horse-power.

Another model (No. 2) travelling at 17 feet per second, has a velocity of gliding descent of 2½ feet per second, which is the equivalent of 220 lbs. sustained per horse-power. These results are set out in Table II., p. 1006. The corresponding figures are given for the Voisin and Wright machines, due allowance being made for the approximate propeller efficiency in both cases.

It may be regarded as probable that the resistances and rate of power expenditure of the most successful flight machines of to-day, though not actually the best obtainable, will be sufficiently near the minimum for the purpose of approximate comparison.

The results are striking; they not only dispel at once any illusion on the subject of "Langley's" law — the power actually increases in an unmistakable manner with increased velocity—but when the figures are transformed to represent the coefficient of resistance they indicate that this quantity is, roughly speaking, constant. This latter is a really remarkable and important fact, the full significance of which will be appreciated later.

We will now pass to the theoretical aspect of the subject, and firstly we have to consider the laws that govern the pressure reaction experienced by planes and other bodies in motion in a fluid.

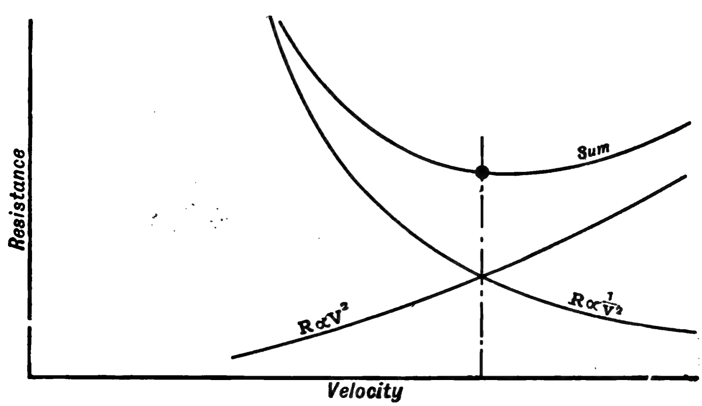
There is one law that, as a close approximation, is applicable to all cases of fluid resistance—between certain limits of velocity: this is the "V^2 law." It is expressed by saying that for a given body in stated presentation the fluid dynamic reaction, or the component of the fluid dynamic reaction in any specified direction, is proportioned to the square of the velocity. It is almost needless to remark that the rate of doing work in overcoming the line-of-flight component of the pressure reaction is equal to this component multiplied by the velocity, V; hence a corollary to the V-square law of resistance is that the power varies as V^3. This is by no means the correct law for the power expended in flight.

The question arises at once—If the V^2 law is a generalisation, why should it not apply to the case of a bird or machine in flight? The reason that the law of flight resistance is not the V^2 law, is that one of the pressure components, the vertical component, is defined: it is the weight of the body and is constant. There is a certain velocity at which the weight of any given bird propelled through the air would be just sustained; at velocities less than this there is a deficit in the sustaining force, at greater velocities there is an excess. Now if by some occult means the weight of a bird could be made to vary as the square of its velocity of flight, the V^2 law of resistance and the V^3 law of power expended would apply; but in the absence of such variation, that is to say, with $W =$ constant, the bird requires to alter the shape or angle of its wings so as to derive from the air just the necessary pressure reaction and no more, and this alteration of shape or angle gives rise to new conditions and laws of an altogether different kind.

Most of the experimental work on the present

subject has been done with planes, and not with curved forms as the wings of a bird, but these aeroplane experiments have furnished results of the right kind. In brief, it has been shown that if the surfaces were not subject to skin friction the resistance would become less when the velocity becomes greater according to an inverse square law; this law may be regarded as an approximation of a sufficiently exact kind for planes of any reasonable *aspect ratio* so long as the angle of incidence of the plane is small. If this law—the law of frictionless flight—actually held good, the power required would, as believed representing their sum. Now here a fact is apparent of which the proof is given in the author's work;* the total resistance has a minimum value at the point where the two different kinds of resistance are equal one to the other; thus, if an aeronaut requires to travel from one point to some other point on the least supply of fuel he will choose the velocity corresponding to this point of least resistance. If, on the other hand, an aeronaut desires to fly with the least possible expenditure of power he will require to fly at a lower velocity, for the horse-power, *i.e.*, rate of doing work, is proportional to the resistance multiplied by the

FIG. 1.



by Wenham and Langley, diminish as the speed increases; but this is far from being the case, for the tangential drag (or skin friction) is considerable; according to recent experiments the resistance of a thin plate moving edgeways is commonly between ·006 and ·020 of the resistance of the same plate moving normally, *i.e.*, at right angles to its surfaces. This ratio is expressed in the author's work, "Aerial Flight," by the symbol ξ, termed the coefficient of skin friction; it is the *double-surface* coefficient, and varies in approximate accordance with the V^2 law; hence the resistance due to the organs of flight consists of two parts which vary in an opposite manner with respect to variations of velocity.

In Fig. 1, in which abscissæ represent velocity and ordinates resistance, we have two curves representing respectively these two kinds of resistance, following the V^2 and the inverse V^2 laws, and we have a third curve velocity, that is, to the product of the abscissæ and ordinates of the curve (Fig. 1). This is of minimum value where the aerodynamic resistance is equal to three times the direct resistance.†

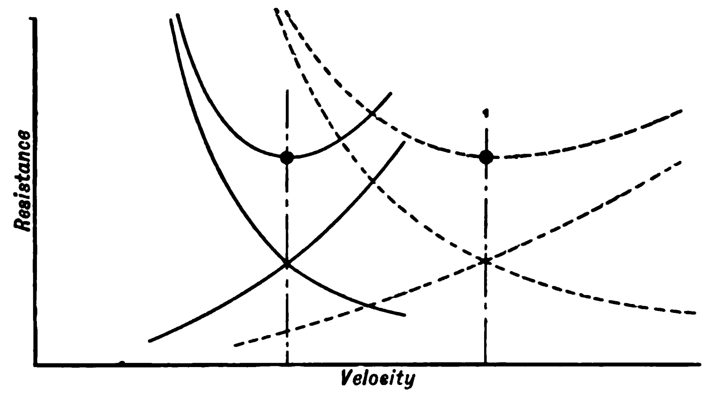
We have hitherto supposed that the bird or aeronaut can alter the angle of his supporting members, but we have not supposed him able to alter the area. If, as is the case with many birds to some degree, we suppose changes of area possible, the conditions become more complicated and we are faced with new and different laws.

For each change of area we have a new pair of curves of aerodynamic and direct resistance, and a new total curve (Fig. 2), and thus we can no longer represent all the possible changes on a two dimensional or plane diagram. But now the object we have in view may be taken into account as a factor limiting the

* "Aerial Flight," Vol. I, Aerodynamics, §§ 164, 176.

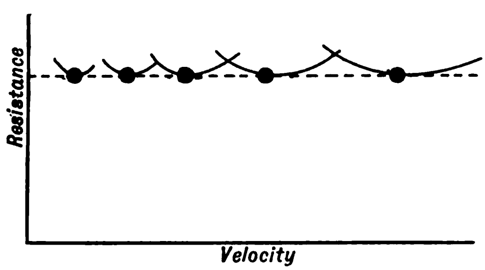
† "Aerial Flight," Vol. I., Aerodynamics, § 164.

FIG. 2.



conditions. Since the practical problem is to get from one point to another with the least possible expenditure of energy, we need only consider the portions of the different curves at and around their points of minimum value. Thus in Fig. 3, if we draw a number of these total

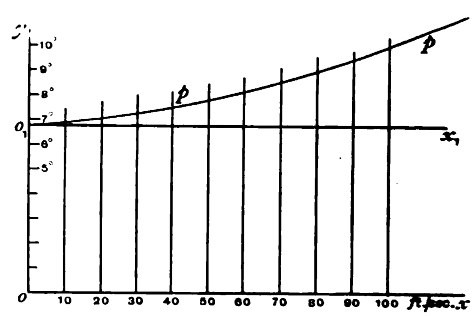
FIG. 3.



curves and draw a curve passing through the minimum point of each, we shall have a curve giving the resistance for variations of velocity on the assumption that the area and angle have been adjusted in every case for minimum value. It is one of the results obtained by the author, that for a given weight sustained this minimum value is constant.* This throws considerable light on the constancy of resistance coefficient for various models and machines at different velocities given as a matter of experience in Table II. In addition to the resistances considered as forming the total in the investigation by which the above result is given, there is a cause of resistance that is best considered apart from the flight resistance proper—that is, the resistance due to the invariable parts of the bird or machine, or body resistance. This body resistance increases (in accordance with the V^2 law) directly as the square of the velocity, and is substantially unaffected by the alterations of area and angle contemplated in the preceding investigation.

To summarise the position, we may (assuming the condition of least resistance to be complied with) suppose the resistance to flight to consist of two parts, one of which is

FIG. 4.



constant and comprises the resistance due to the flight organs, and the other of which, due to the body, varies directly as the square of the velocity. These two kinds of resistance are represented in Fig. 4, in which the constant resistance is given by the horizontal line O x, and the added or body resistance by the line p p.

In Fig. 4 the ordinates give the coefficient of resistance as an angle—the *gliding angle* of free descent.

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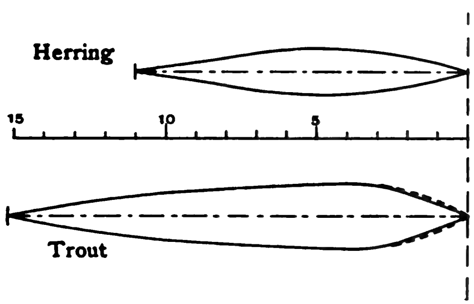
* Comp. "Aerial Flight," Vol. I., Aerodynamics, § 166.

It is at the present juncture worthy of note that there is thus a close analogy between the flying machine and an ordinary motor car climbing a steady gradient. The flight resistance corresponds to the gradient resistance, which does not vary with changes of velocity, and the body resistance of the flying machine is strictly analogous to the "wind resistance" of the motor car; it arises from the same identical cause, and varies according to the same law.

In order to diminish as far as possible the body resistance, the body or mechanism should be enclosed by a stream-line or ichthyoid form. It is not known with precision what the correct form of least resistance may be, for no theory is known by which the best form, in the case of a real fluid can be deduced. It is generally understood that forms of smooth

FIG. 5.



contour and fined off stem and stern do not give rise to motion of the discontinuous type,* and this (*i.e.* the absence of discontinuity) is the essential feature of stream-line motion. The author has measured certain fish forms which, reduced to solids of revolution, are given in Fig. 5; these seem rough approximations to paraboloids (in which the axis of revolution is parallel to the *latus rectum*), but in which the maximum section is about 7-16ths from the nose.

The resistance of forms such as those illustrated is not very accurately known. Various observers give it in the case of the ·15 form, that is, about 6 : 1 ratio, as from 1-8th to 1-30th of the resistance of a normal plane of the same "projected area." It is probable that the coefficient of resistance thus defined for a well-designed fish form of 1 : 6 ratio varies as a function of the size and velocity; for small forms at low velocities it may be as high as, or even higher than, ·125, whereas for large bodies it is probable that as low a coefficient as ·06 may be obtained. The author believes that for well formed bodies it is usually between these limits. The present case is merely an example of the want of agreement commonly met with in experimental aerodynamics.

It is evident, referring again to Fig. 4, that for low flight velocities the body resistance becomes relatively unimportant, and the loss of power due to a badly formed stream-line body may be inconsiderable. For high velocities on the contrary, the body resistance, even with the most carefully designed form, may constitute a large part of the total resistance, and the greatest care becomes necessary to prevent the expenditure of power from this cause from becoming excessive.

Having discussed the means by which the body resistance may be minimised, we will now revert to the question of the conditions governing the flight resistance proper, the constant component of Fig. 4.

The influence of variation in the coefficient of skin friction is rendered evident by the curves shown in Fig. 6, in which the line represents the curve of total resistance that results from a reduction in the skin friction corresponding to the difference between the lines 1 and 2; it is evident that the minimum resistance value given by this curve is less than previously.

Several writers—notably Wenham, Langley, Dines, and Maxim—have stated that the influence of skin friction is negligible, and Langley gives the value or the coefficient as approximately ·00015, as against the author's result about fifty times as great. If the value were actually as stated by Langley, skin friction, under the conditions of flight as at present known to us, would in effect be negligible; but there is no doubt that Langley's statement is in error.

If it were possible, the correct way to measure skin friction would be to measure directly the tangential drag experienced by a plane in edgewise motion. In practice the experiments have to be made on a plate of some material possessing thickness, which, strictly speaking, is a departure from the conditions; the author has made determinations in this way by means of an instrument termed an aerodynamic balance,* the plate being made of stream-line section. It is useless to experiment with planes with square cut edges owing to the fact that the air set in motion by the lead-

* See Appendix.

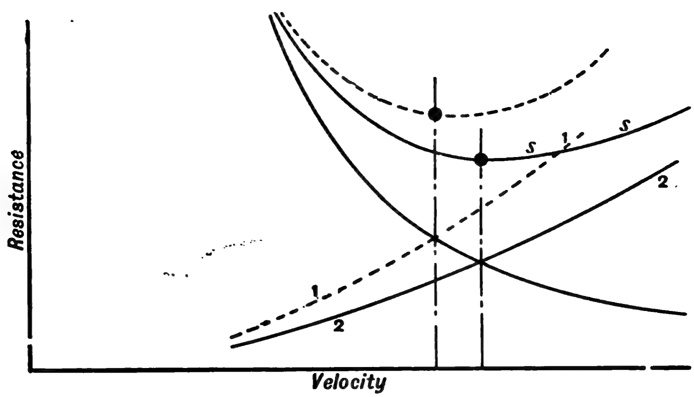
* "Aerial Flight," Vol. I., § 246.

ing edge of the plane relieves the skin-friction on the surfaces along which it passes to a very great extent, and so if a deduction for the edge area be made the calculated coefficient will be far below its true value.

this way. Beyond this the coefficient undoubtedly is less for high velocities and large surfaces, than when the area is small and the velocity low.

The other important factor by which the

FIG. 6.



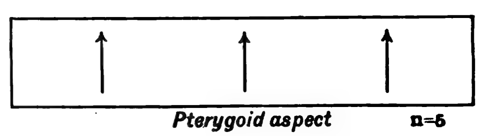
It is not easy by means of apparatus of a portable kind to demonstrate even the existence of skin-friction to an audience, but the following method has been used by the author. If a sphere whose centre of gravity and centre of pressure coincide, be surrounded and supported by fluid in which skin-friction is absent, it will be manifestly impossible for the sphere to acquire rotation or to lose any rotation initially imparted to it, for forces acting between the surface of the sphere and the fluid will have no tangential component, and hence will all pass through the centre; but the force of gravity also passes through the centre; hence all forces acting on the sphere pass through its centre, and they cannot give rise to a couple.*

It is evident that the only direction in which a direct effort can be made to reduce the coefficient of skin-friction is by employing materials as smooth as possible, if not actually going to the length of varnishing or polishing the surfaces. It is known that some small

reduction in the coefficient may be effected in constant flight resistance is influenced is aspect ratio.*

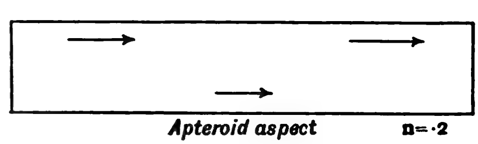
If a given weight is sustained by a plane at a stated angle the area required is less for planes in pterygoid aspect, Fig. 7, than in

FIG. 7.



apteroid aspect, Fig. 8, and as a general proposition the area required is less the greater the aspect ratio. It is a consequence of this

FIG. 8.



* A demonstration by this method was given by the author at a Lecture to the Liverpool Engineering Society, Feb. 9th, 1909. In the experiment, as tried, a small celluloid ball was supported on a jet whose nozzle velocity was probably about 150 feet per second, and the speed and direction of rotation are found to undergo continual change, proving conclusively that skin-friction exists. A rough computation made from the rate of change of rotation and the velocity of the air jet gives a value of the coefficient of the right order of magnitude, as determined by other modes of experiment.

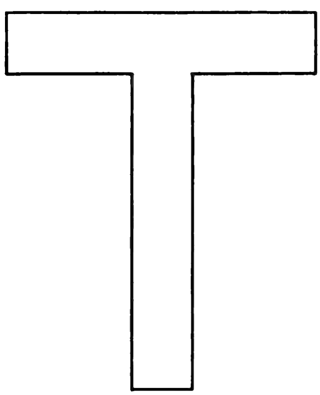
* The term "aspect" in its present usage was first employed by Langley to denote the attitude of a plane in azimuth in relation to its direction of flight. The term "aspect ratio" has been introduced by the author to denote the proportions of the plane or wing surface, *i.e.*, "aspect ratio" is span in terms of fore and aft dimension ("Aerial Flight," Vol. I., Aerodynamics, § 150).

that the use of planes of great aspect ratio results in economy, for the necessarily exposed surface is less, and thus the skin friction is diminished.

The same facts apply equally to supporting members of other than plane forms, and hence a considerable aspect ratio is a *sine qua non* if economy is desired. The aspect ratio employed by nature varies considerably, but amongst birds it is found as low as 4 in the case of the lark and scops owl, and may be as high as 13 in the wandering albatross.

An experiment of a very simple kind, originated by the author some years ago, may be easily made to demonstrate the importance of "aspect ratio." A piece of stout paper cut to the shape of the letter T (Fig. 9) is allowed

FIG. 9.



to fall head first, when it is found to be unstable and will turn over. If, on the other hand, it be let fall stem first, it will be seen to drop vertically like a stone.

When the T assumes accidentally a very slight inclination to its direction of motion the pressure reaction on the head which is in pterygoid (winglike) aspect is greater than that on the tail which is in apteroid aspect. Hence for small angles the centre of pressure is always nearer the head than the centre of gravity and the stem of the T may be regarded as acting as ballast. If the pressure reaction were the same in pterygoid as in apteroid aspect the T would fall equally well (or badly) whether suspended from its head or stem.

A feature commonly found associated with the development of aspect ratio in nature and conducive to the economical sustentation of the load is the arched section, the advantages of which (in connection with mechanical flight) were first clearly established by Horatio Phillips in this country and by Lilienthal in Germany. This feature is illustrated in Fig. 10, which represents the section of the wing

FIG. 10.

(Herring Gull)

of a herring gull; a most remarkable feature associated with the arched section is the dipping front edge which may be observed whenever birds in gliding or soaring flight are seen under sufficiently favourable conditions.

The advantages derived from great aspect ratio and from the dipping front edge are due to the form of motion—the fluid dynamic system—by which the supporting member or aerofoil is surrounded. The author has shown that this system comprises what is termed in hydrodynamic theory a cyclic component, a type of motion with which we are most familiar in the particular case of the vortex ring, and which is sometimes in consequence known as vortex motion.

In an inviscid fluid—the ideal fluid of mathematical theory—cyclic motion can only take place in what is termed a doubly or multiply connected region, that is, a region that is looped by an obstacle; for example, the spaces either surrounding or internal to the surface of an anchor ring are said to be doubly connected. Now, in the case of the wings of a bird or the aerofoil of a flying machine the cyclic motion takes place in the vertical plane of flight, and the greater the aspect ratio the better it lends itself to the type of motion in question; nevertheless, whatever the span of the aerofoil may be, unless we consider it as infinite, the surrounding space remains a simply connected region, and cyclic motion only becomes possible by reason of the viscosity of the fluid.

The manner in which viscosity, however small, gives rise to so fundamental a difference in the behaviour of a fluid is one of the problems at present in progress of solution; it appears to initiate something in the nature of instability in the systems of flow established by theory for the perfect fluid, and so the resulting changes are out of all proportion to

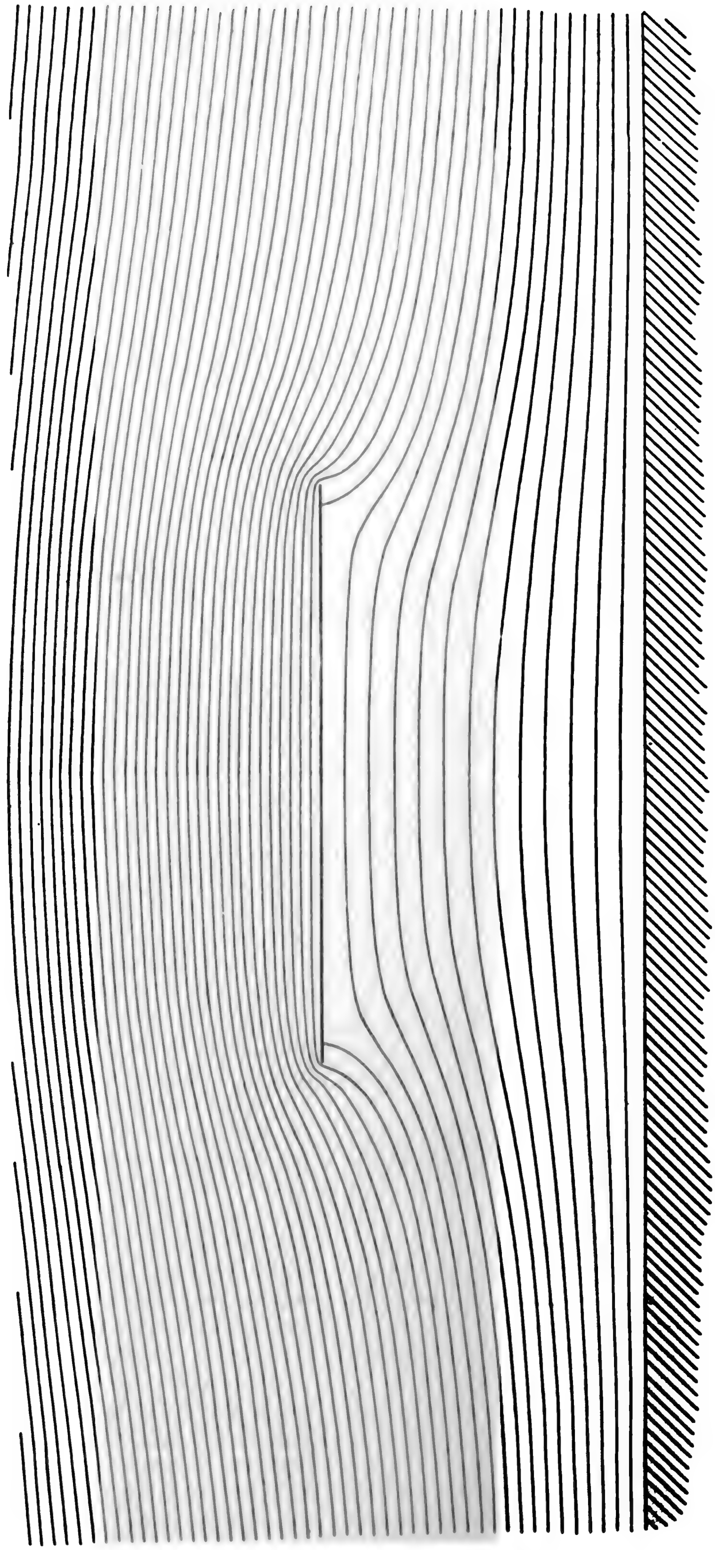
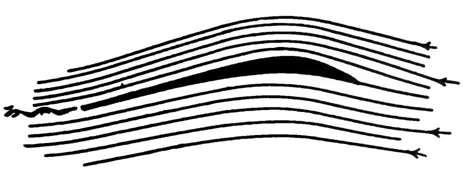


FIG. 11.

the effect that produces them. In any case the possibility of a cyclic system in a simply connected region in a real fluid must to-day be accepted as established, and for the present purpose it is sufficient to draw attention to the bearing of this fact on the branch of the subject under discussion.*

Fig. 11 represents the ideal case of a cyclic motion about an infinite plane lamina in motion in an inviscid fluid. Here a load will be sustained indefinitely by the aeroplane without any expenditure of energy, the cyclic system superposed on the motion of translation gives rise to the stream-line system depicted which is a conservative system of the general character of a wave on the crest of which the aeroplane is sustained. The system is symmetrical in this case and therefore the diagram may be read in either direction; it will be seen that the fluid rises to meet the plane during its approach, gives up its upward momentum to the plane and receives downward momentum, this exchange of momentum giving rise to the supporting reaction.

FIG. 12.



In a real fluid a plane such as depicted would give rise to a discontinuous system of flow and to take full advantage of the cyclic system the leading edge must dip to meet the upcurrent and the trailing edge must also dip to conform to the direction of the stream-lines. Thus a suitable section is given in Fig. 12. Under actual conditions also the lateral dimension or "span" is not infinite and this results in a continual lateral dissipation of the supporting system which has to be made good by work done by the aerofoil; it is, therefore, necessary to impart a greater downward velocity to the air than that of the upcurrent received.

Thus the cyclic theory of the periptery supplies the key to the solution of the problem of aerofoil design; if the use of that key is not yet fully mastered it is due to the newness of the subject rather than to its intrinsic difficulty.

Basing his investigation on the foregoing theory the author has established certain important relations connecting the form of suction of the aerofoil, the pressure per square foot, and the velocity of flight, proper to least resistance. Thus there is a definite relation between the weight sustained per unit surface and the square of the velocity of flight* that results in the least resistance to flight, and this relation may be calculated with a fair degree of accuracy if the value of the aspect ratio and the coefficient of skin friction are given. The appropriate values (taken from Table IX. from the author's "Aerial Flight") are given in Table III. for different values of aspect ratio from 3 to 8 for values of the coefficient ξ = ·02 and ·01, the aerofoil being taken as of the arched section (or pterygoid form) discussed in the author's work. The value of the constant in the case of a true (or plane) aeroplane is considerably lower.

An interesting point arises in connection with the value of the coefficient ξ. It is known that, other things being equal, ξ diminishes according to some unknown law as the size of a plane is increased. There is also experimental evidence to show that it also becomes less for high velocities. Beyond this, there are theoretical grounds for supposing that the change in respect of velocity is of identical form with the change in respect of size, and that so long as the product of linear size and velocity (L V) is constant, the value of ξ is constant. Now if we design a number of aerofoils of the same aspect ratio to comply with the condition of minimum resistance to support a given weight, W, at different velocities of flight, we know as in Table III., the area multiplied by V^2 is constant, and the area is proportional to the square of the linear dimension: hence L^2 V^2 is constant, or L V is constant. Consequently we have the rather unexpected result that the coefficient of skin friction (assuming the conditions as those of least resistance), is independent of the size or the velocity of the machine. In other words, as soon as we have settled the weight of the machine, and the aspect ratio it is proposed to employ, the value of the appropriate coefficient is determined.

In practice, the extent to which the theore-

* In his "Aerial Flight," Vol. I., the author has discussed the whole question very fully (cc. iii. and iv.). It is there shown that the conditions of double connectivity are simulated by vortex filaments being continuously generated at the right and left hand extremities of the aerofoil which trail behind in the fluid, their contained rotation becoming distributed and their energy dissipated.

* This must not be mistaken for a mere re-statement of the V^2 law; it rests definitely on the proof given in the author's work. That the law of best pressure value corresponds to the V^2 law is counterpart to the fact that the best angles of dip and trail are constant in respect of velocity variations.

tical requirements can be fulfilled, has certain limitations. Constructional considerations prescribe a limit to the aspect ratio that can be employed; secondly, the question of the weight of the aerofoil makes it undesirable to utilise as much surface as the simple theory would indicate; this point is investigated more fully in the author's work, and a general solution is given. Thirdly, the struts, guy wires, &c., used perforce in the aerofoil of a full scale machine offer considerable resistance of a kind that varies roughly as the area employed and the square of the velocity; this resistance has to be considered as part of the direct resistance of Fig 1, and may be dealt with by a special coefficient computed from a trial design, and added to the coefficient of skin-friction; in fact, these resistances in effect augment the skin-friction coefficient. Struts, guys, &c., forming part of the frame of the chassis of the machine, on the other hand, undergo no changes with change of area, and therefore form part of the body resistance.

From computations that the author has made, it would appear probable that the total resistance of the flight organs—the constant resistance of Fig. 4—is in the case of many of the present successful flying machines about 10·1 of the weight, and the difference between this and the co-efficient of traction, given in Table I., is that properly classed as body resistance; however, the machines vary considerably amongst themselves, and computations made on data at present ascertainable cannot be implicitly relied upon; an error of 10 per cent. might easily exist.

In the case of birds it is probable that the coefficient of traction is commonly from 12 per cent. to 20 per cent., about one-sixth of which is body resistance.

It is worthy of remark that the velocity of flight of the various present-day machines is not widely different. This is due, on the one hand, to the fact that at speeds below 30-35 miles per hour through the air the maintenance of equilibrium becomes a grave difficulty, so much so as to render flight dangerous except in the calmest weather, and on the other hand to the fact that the maximum possible velocity of flight is proportional to the power carried, and as yet the petrol motor has not been sufficiently reduced in weight to leave a great margin of horse-power. It is natural that working under the restriction as to horse-power the earliest successful attempts at flight should be made at speeds very little in excess of the minimum safe limit!

TABLE I.

COEFFICIENTS OF TRACTION (OR RESISTANCE) PROPER TO DIFFERENT MODES OF LOCOMOTION.

	Resistance as percentage of weight.
Land Vehicles.	
(*a*) On Common Roads:—	
Iron tyres (value dependent on nature and condition of road surface)	2 to 3·5
Solid India Rubber ditto ditto (about)	3
Pneumatic (depends less upon road surface) ....(about)	2·2
(*b*) On Steel Rails:—	
Express passenger train .... (about)	1
Slow train (minimum under most favourable conditions)	·25
Ships.	
Fast passenger vessel, *Lucania*	·7
Slow cargo or "tramp" steamer....	·25 to ·1
Dirigibles.	
Ville de Paris (at full speed) about	6
Zeppelin III. (ditto) ,,	5
Flying Machines.	
Voisin (approximate)..............	13·5
Wright ,, ...	12

TABLE II.

POWER EXPENDED IN FLIGHT AT DIFFERENT VELOCITIES.

	Velocity ft./sec.	Pounds sustained per h.p.	Resistance per cent.
Lanchester—			
Model No. 1......	5	550	20
Model No. 2......	17	220	14·7
Voisin..............	50	31	13·5
Wright	58	79	12·0

TABLE III.

VALUES OF P/V^2 FOR LEAST RESISTANCE.

Aspect ratio.	$\xi = \cdot01$	$\xi = \cdot02$
3	·0153	·0218
4	·0170	·0242
5	·0188	·0266
6	·0204	·0286
7	·0215	·0305
8	·0231	·0326

Absolute units. (British units, poundals per square foot, and feet per sec.)

HOME INDUSTRIES.

Electric Driving.—It is a little surprising that electrical driving has not, as yet, made much headway in the cotton and woollen industries. There are more than 53,000,000 spindles dealing with the raw material of cotton, or, including spindles producing waste yarns, over 57,000,000, and the number of looms exceeds 739,000. But very few of these spindles and looms are electrically driven. Nor is it

likely that whilst the present depression in the cotton trade lasts, many spinners and manufacturers will be prepared to reorganise their power plant, and instal electricity as a motive power. It may be expected, however, that when the next cycle of prosperity comes, there will be considerable resort to electricity. Its advantages, as they apply to cotton machinery, are many. It saves friction. Even with the highly-perfected steam drive there is considerable loss in power throughout the mill, due to friction in the engine, the rope race, the shafting, and the belting. A correspondent of *The Times* (October 20th) gives a recent case of a mill tested, when it was found that the engine had to develop 1,252·20 horse-power, in order to drive the mill satisfactorily, although the machines only needed 895·96 horse-power as a *maximum*. Taking a percentage on the power required for useful work, 39·76 per cent. extra power was needed beyond that for working the machines themselves. If the mill had been electrically driven, and the current had been bought from a supply corporation, the consumer would have had to pay for only 861·41 horse-power, of which 783·98 horse-power would be utilised in useful work. The difference between the latter figure, and the 895·96 horse-power which would be absorbed if all the machinery were running, is accounted for by the fact that, during part of the time, doffing, grinding, stripping and similar operations have the effect of keeping certain machines standing. Other advantages of electrical driving, as compared with steam, are—(1) that the prime mover and the machinery can be placed in any relative position, and that each machine can be driven independently without reference to the others; (2) the steadiness of the drive is increased; (3) a more regular and therefore better selling yarn is produced; (4) there is a greater immunity from general breakdown; (5) in the erection of new mills much lighter structures can be designed, and utilised by dispensing with shafting, pulleys, and belting, and so saving much weight, while in combination with buildings of reinforced concrete, electrically driven mills can be constructed at smaller cost than the mill buildings now used. The mills already electrified are examples of what can be done, but each mill must be individually considered, and treated on its own merits.

Canals and Waterways.—Volume VI. of the Report of the Royal Commission on Canals and Waterways has just been issued. It contains the reports on the waterways of France and Belgium, Germany and Holland, drawn up by Mr. W. H. Lindley, who was appointed an Assistant Commissioner for this purpose. The report contains a mass of information upon foreign waterways, and shows in great detail how much these several States have done to preserve and extend their inland waterways. A different policy has been followed in this country. So long ago as 1121 Henry I. deepened and rendered "partially navigable" the old Roman Fosse Dyke, which, in a sense, may be called the first British canal, and in 1563 a pound lock canal was constructed from Topsham to Exeter, similar in all essential points to one of the present day, but it was not until 1760 that a navigable canal of considerable length—from the Mersey to St. Helens—was completed, and a century later the great railway companies obtained the control of our inland navigation system which has brought it to its present lamentable condition. The demonstration of the evils resulting from this policy by various Departmental Committees and Royal Commissions has produced some remedial legislation on the subject, but it has hitherto yielded little or no result.

The Working of the Patents Act.—It is made plain by the reports of various Continental manufacturers' organisations that they regard the new Patents Act in this country as putting two serious obstacles in their way. The question of international patent law was one of the subjects discussed at the annual meeting of the International Society for Industrial Legal Rights, held at Nancy, and the following resolution was passed:—"The Congress is of opinion that no country should compulsorily enforce the working of patents, and it is in the highest degree desirable that the law on the subject should at least be uniform in all countries." It is suggested that the working of a patent in any one country should be considered sufficient, and in case of its not being worked at all the penalty should not be the withdrawal of the patent rights, but the legal right for a license on the part of anyone desirous of working the patent. The congress is further of opinion that in any case the patent should not be annulled if the patentee can show that he has offered to grant licenses on fair terms to interested parties and these have refused to take them up. Finally, the patent rights should not be withdrawn if it can be shown that the industry in the country itself is equal to that represented by the quantity of the patented articles in question actually imported.

The Census of Production (1907).—The Census of Production discloses some striking facts with regard to the relative magnitudes and values of the home and export trades in the various goods. It will surprise many to find that the export of broad woollens is of an average quality higher than such as are retained for home use, yet it appears that the average value of those produced is 2s. 1¾d., and the average of exports 2s. 8½d. The export of these is 50·4 per cent. of the production in quantity, but 64·3 per cent. in value. So in narrow woollens, a class including low dress Melton and similar goods, as well as woollen trouserings, exported goods are on the whole of a superior kind to those made for the home trade. In broad worsted coatings, 44 per cent. of which are exported, the export and the general price are almost equal. Carpets, 36 per cent. of which are exported, have the same average price of 2s. 7d. alike in export and production. The blanket trade is three parts home trade and the blankets exported are valued lower by 7½d. a pair than the

9s. 5d., which is the 1907 value of all that were manufactured. Flannels and delaines are still more of a home trade than blankets, the exported proportion being less than 20 per cent. Of plush only 8.7 per cent. of the yardage goes abroad, and of damasks, tapestry, and furniture stuffs, only 6 per cent. Damask weaving is a dwindling trade and there is not much business done at home in tapestry looms. Roughly the home and shipping branches of the woollen and worsted cloth industries are about equal in importance. Of coal, 265,134,000 tons were raised in 1907, and of this quantity only 182,914,000 remained in the United Kingdom.

The Cotton Position.—There is no longer any doubt that the American cotton crop will be a short one. The damage inflicted to the crops of Louisiana and Missisippi by the hurricane of September 20th, was exaggerated, but the loss sustained in both yield and condition of the staple is nevertheless considerable. In many sections, some of the cotton carried to the ground by the violent winds has been saved, but the quality and grade are found to be affected. At present cotton is plentiful owing to the rush to market, but values have reached such a level that cotton mills cannot produce finished goods, and sell them at a remunerative price. In consequence, there is a movement on foot on the part of manufacturers to curtail production, and according to the *New York Journal of Commerce*, "if the present plans of manufacturers mature, the reduction in the consumption will amount to one million bales in the United States alone. The proposal is for a short time to the extent of 224 hours, during the present cotton season, the agreements to become effective if not less than seven million spindles shall have been signed up. To save one million bales, roughly, the equivalent of a stoppage of 6 per cent. of all the spindles in the States for a year is necessary. The *Journal of Commerce* says that even the curtailment of a part of the seven million spindles is not likely to become effective in the immediate future, "as many of the mills that will sign an agreement will be unable to fill present orders without steady running well into January." It is difficult to get at the truth from contradictory statements of this kind. If a mill has orders that will keep it working until January, it is not probable that it will bind itself to shut up for 224 hours after that time. If the present high prices continue, it is pretty certain that there will be a considerable decrease in the use of cotton in the United States, but a reduction in the consumption of one million bales is quite another matter.

MEETINGS FOR THE ENSUING WEEK

MONDAY, Nov. 1...Farmers' Club, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Major P. G. Craigie, "Farm Labour and the Cost of Production."

Royal Institution, Albemarle-street, W., 3 p.m. General Monthly Meeting.

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. J. H. Coste, "Technical Gas Calorimetry." 2. Messrs. W. P. Jorissen and J. Rutten, "Naphthalene Picrate and the Quantitative Determination of Naphthalene." 3. Mr. J. C. Stead, "Some Notes upon the Manufacture of Large Blocks of Artificial Stone from Sand and Lime."

British Architects, 9, Conduit-street, W., 8 p.m. 1. President's Address. 2. Presentation of Royal Gold Medal to Dr. Arthur J. Evans, and Address by Dr. Evans on "Recent Discoveries in Crete."

London Institution, Finsbury-circus, E.C., 5 p.m. Dr. P. C. Mitchell, "The Feeding of Animals in Captivity."

TUESDAY, Nov. 2...Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Address by the President, Mr. James C. Inglis. 2. Reception in the Library after the Meeting.

Colonial Institute, Whitehall Rooms, Whitehall-place, S.W., 8 p.m. Sir John Cockburn, "Signs of Imperial Solidarity."

WEDNESDAY, Nov. 3...Geological, Burlington-house, W., 8 p.m. 1. Mr. S. S. Buckman, *a.* "Certain Jurassic (Lias Oolite) Strata of South Dorset, and their Correlation." *b.* "Certain Jurassic (Inferior Oolite) Species of Ammonites and Brachiopoda." 2. Dr. W. F. Hume, *a.* "The Cretaceous and Eocene Strata of Egypt." *b.* "The Granite Ridges of Kharga Oasis: Intrusive or Tectonic?"

Royal Archæological Institution, 20, Hanover-square, W., 4½ p.m. Mr. R. Garraway Rice, "Portions of Sussex Churches which can be dated from Bequests in Early Wills." (Part II.)

THURSDAY, Nov. 4...Linnean, Burlington-house, W., 8 p.m. Prof. H. H. W. Pearson, "Some Account of the Field Botany of Namaqualand, Damaraland, and South Angola."

Chemical, Burlington-house, W., 8½ p.m. 1. Mr. H. M. Dawson and Miss H. S. Leslie, "Dynamics of the Reaction between Iodine and Acetone." 2. Mr. J. F. Thorpe, "The Formation and Reactions of Imino Compounds." (Part XI.) "The Formation of 1-imino-2-cyanocylopentane from Adiponitrile."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. F. Martin Duncan, "The Romance of Plant Life."

Civil and Mechanical Engineers, Caxton-hall, Westminster, S.W., 8 p.m. Mr. A. S. E. Ackermann, "Technical Popular Fallacies."

East India Association, Caxton-hall, Westminster, S.W., 4 p.m. Mr. Atul Chandra Chatterjee, "The Need and Methods of Industrial Development in India."

FRIDAY, Nov. 5...African Society, Trocadero Restaurant, Shaftesbury-avenue, W., 8 p.m. Address by Herr Dernburg.

Architectural Association, 18, Tufton-street, S.W., 7½ p.m. Mr. W. D. Scott-Moncrieff, "Drainage and Sewage Disposal."

Geologists' Association, University College, W.C., 8 p.m. Conversazione.

Anthropological, 50, Great Russell-street, W.C., 8½ p.m. (Huxley Memorial Lecture.) Prof. Gustaf Retzius, "The North-European Races."

Engineers, Caxton-hall, Westminster, S.W., 7½ p.m. Dr. David Sommerville, "Some Observations on the Chemistry and Bacteriology of Sewage Purification."

SATURDAY, Nov. 6...Educational Handwork Association (at the HOUSE OF THE ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.), 3 p.m. Dr. T. P. Nunn, "The Educational Value of Handwork Teaching."

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FRIDAY, NOVEMBER 5, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

CANTOR LECTURES ON "AERIAL FLIGHT."

The Secretary very greatly regrets that Mr. F. W. Lanchester having failed to supply the MS. of the second lecture of the course on "Aerial Flight," it is not possible to publish it in this number of the *Journal*. It is hardly necessary to say that every effort has been made to induce Mr. Lanchester to fulfil his contract with the Society, and the Secretary can only express his profound regret at his lack of success.

No information as yet can be given as to the publication of this, or the third Lecture.

CANTOR LECTURES ON "ARTIFICIAL ILLUMINATION."

The Cantor Lectures on "Modern Methods of Artificial Illumination," by Mr. LEON GASTER, Editor of the *Illuminating Engineer*, have been re-printed from the *Journal*, and the pamphlet (price two shillings) can be obtained on application to the Secretary, Royal Society of Arts, John-street, Adelphi, London, W.C.

A full list of the Cantor Lectures, which have been published separately and are still on sale, can also be obtained on application.

ARRANGEMENTS FOR THE SESSION.

The Opening Meeting of the One-Hundred-and-Fifty-Sixth Session will be held on Wednesday evening, the 17th of November, at 8 p.m., when an address will be delivered by SIR WILLIAM H. WHITE, K.C.B., LL.D., F.R.S., Vice-President and Chairman of the Council. The subject of the address will be "An Imperial Navy."

The following arrangements have been made for meetings previous to Christmas :--

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock :—

NOVEMBER 24.—T. THORNE BAKER, F.R.P.S., "Photo-Telegraphy."

DECEMBER 1.—HON. RICHARD C. PARSONS, M.A., "Resilient Wheels for Vehicles."

DECEMBER 8.—JAMES BUCKLAND, "The Destruction of Plumage Birds."

DECEMBER 15.—H. PEARSON, "The Diamond Fields of Brazil."

COLONIAL SECTION.

Tuesday afternoon, at 4.30 o'clock :—

NOVEMBER 30. — SAMUEL SIMPSON, B.Sc., M.R.A.S.E., "Agricultural Development in Nyasaland."

INDIAN SECTION.

Thursday afternoon, at 4.30 o'clock :—

DECEMBER 9.—SIR JAMES WILSON, K.C.S.I., "The Punjab."

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

CHARLES CYRIL TURNER, "Aeronautics." Four Lectures.

LECTURE I.—NOV. 29—Aerostats and aeronefs—Ballooning and its future—Possible lines of development—Kites—Birds—Is flapping wing flight imitable? —Soaring flight—Gliding flight—Action of the air on plane and curved surfaces—The leading or "entering" edge—Aspect ratio—The inclined plane—The curved plane — The concavo-convex plane — The gliding angle—Air resistance—Stream-line form—The atmosphere — Different qualities of air—Air propellers.

LECTURE II.—DEC. 6.—Dirigible balloons—Comparative efficiency of different types—The elevator—The ballonnet—The compartment system—Methods of suspension—Stability—Motors and propellers—The ascent and the landing—Harbours—Capacity and utility of dirigible balloons.

LECTURE III. — DEC. 13. — Aeroplanes, helicopters, and ornithopters — Present failure of the two latter—The simple glider—Principles of stability. —The question of automatic stability—The relation of

speed to stability—Various methods of obtaining stability — The compartment system — Adjustable planes—Flexible planes—Some suggestions—Starting and alighting—Position of the pilot.

LECTURE IV.—DEC. 20.—Flying-machine motors and propellers—Specialised flying-machines—Differentiation of type—Limitations—Practical results—Uses of the flying-machine—Navigation of the air—Flying by night—Special maps and landmarks—Possibilities in war.

Papers to be read after Christmas :—

H. S. SMITH, "Oxy-Acetylene Welding."

E. COOKE, "The Teaching of Design."

CHARLES JOHN STEWART (Public Trustee), "The Public Trustee and his Work."

CYRIL DAVENPORT, "Miniatures."

KENNETH GRAY, "Heating and Ventilation."

E. B. HAVELL, late Superintendent Calcutta School of Art and Art Gallery, "Art Administration in India."

GEORGE OWEN DUNN, M.Inst.C.E., Chairman, Bombay City Improvement Trust, 1904-1909, "The Bombay Housing Question."

SIR RICHARD CARNAC TEMPLE, Bart., C.I.E., "The People of Burma."

DR. JOHN MCCALL, Agent-General for Tasmania, "Fruit Production in the British Empire."

C. G. ZANDER, "Printing Inks."

SYDNEY PERKS, F.R.I.B.A., F.S.A., "The Guildhall: the recent discoveries and restoration."

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

January 13, February 17, March 10, April 21 May 26.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock :—

February 1, March 1, May 3.

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

ALAN S. COLE, C.B., "Textile Ornamentation." Three Lectures.

January 17, 24, 31.

PROFESSOR W. WATSON, D.Sc., F.R.S., "The Petrol Motor." Four Lectures.

February 7, 14, 21, 28.

LAWRENCE WEAVER, F.S.A., "Lead Work." Two Lectures.

March 7, 14.

ALFRED B. SEARLE, M.S.C.I., "Modern Methods of Brick-making." Four Lectures.

April 11, 18, 25, May 2.

JUVENILE LECTURES.

Wednesday evenings, January 5 and 12, 1910, at 5 o'clock :—

PROFESSOR HAROLD B. DIXON, M.A., F.R.S., "The Chemistry of Flame." Two Lectures.

THE PLACE OF RESEARCH IN EDUCATION.*

By HENRY A. MIERS, D.Sc., M.A., F.R.S.,
Principal of the University of London.

The word research has played a very important part in most educational writings during recent years. There was a time when research was supposed to be the province of dry-as-dust university professors, and was not regarded as having many points of contact with ordinary life, or with ordinary education; the man who pursued research might be a teacher with zeal and some leisure for investigation, but was more often a man of means to whom it was a pleasure. He was also regarded as different in kind from the inventor, whose main object was to make a fortune. In Sir James Murray's New English Dictionary the earliest use of the word "researcher" in its modern sense is in a letter from *The Times* of 1883; and there it is actually employed in contrast to teacher.

Faraday is, perhaps, the most splendid example in the annals of British, or, indeed, of European, science of the born investigator—the man imbued with the spirit of scientific research. He was also a heaven-born teacher, and no better lectures than his have ever been delivered to a popular audience; he made the Royal Institution fashionable for London society. But in those days the audience expected to learn from lectures and not by practising the methods of the lecturer; he as a researcher was living on a different plane, and only descended to their level when he came before them as a teacher.

This gulf between teaching and research has been to a large extent obliterated by the universities.

With the rapid growth of the industrial applications of scientific discoveries, which succeeded one another with bewildering rapidity, it has been realised that the training of investigators is one of the most important functions of the universities, and, accompanying the cry for technical education, came the demand for the endowment of research. The University Commission in 1877 recommended the institution of research fellowships. Ever since the days when the Royal Society was founded by a few investigators at Oxford, the universities had from time to time produced small groups of men who were inspired by a zeal for scientific inquiry. Universities were henceforth to be expected to produce a regular succession of researchers.

So remarkable have been the results upon German industry of the scientific labours of highly trained investigators, so fruitful has been been the expenditure of public money upon their training, such astonishing developments have followed the employment of skilled experimentalists in industry and commerce, that the benefits of research are universally recognised. They are even recognised by politicians, and are frequently reckoned in terms of exports. Such achievements as the manufacture of aniline dyes and artificial indigo are familiar examples of the beneficial

* Reprinted from the *Standard* of Nov. 1, 1909.

results of scientific investigation, and it is realised that if a country falls behind in the training of discoverers, the national loss is to be reckoned in millions.

Institutions devoted to special research, such as our National Physical Laboratory and Lister Institute, are now being founded in most countries, manned by staffs of earnest workers trained in the universities and engaged upon systematic inquiries. It is even beginning to be recognised that this work need not necessarily be accompanied by immediate financial and industrial success. The discoveries which have no immediate application sometimes prove to be the most important of all, for they may lead to the establishment of the most fundamental principles. The extraordinarily rapid development of the applications of electricity was in no small measure due to the fact that the mathematical principles on which these applications were based had been already worked out by the mathematical physicists. We may be sure that there will be no lack of research into rubber substitutes, light motors, flying machines, and the other discoveries that lead to fame or fortune; neither is it likely that the investigations of bacteriology, or the search for the causes and the remedies of the mysterious diseases that terrify the pnblic mind, will be allowed to flag; but it is recognised now that from private endowments and the public purse funds should be forthcoming not only for these objects, but also for advanced scientific researches of all sorts; and that it is the duty of the universities to train the brightest intellects for their study.

But, though the industrial applications gave a new stimulus to research as a recognised part of University education, and although in the minds of the public the word may be connected mainly with work which leads to such results, the introduction of research has really effected a far more profound revolution in education. It has meant the introduction of the research spirit. Without this the thing itself may from the educational point of view become a mere shadow.

The teacher who sets his pupil to make observations or to collect details for the investigation which he is himself pursuing, may be doing good service to the cause of science or of learning, and to his own reputation, but unless he also inspires his pupil with an interest in the object to which the work is directed, and a passion for discovery, he may not be doing better service towards the education of the student than by any other exercise.

For, after all, the educational value of research, apart from the actual value of the discoveries made and the materials amassed for further advance, depends entirely upon the inspiration of the teacher and the response of the student. As flint strikes fire from steel, so, when teacher and pupil meet in the clash of original thought do their minds glow with the ardour of discovery; but without that mutual enthusiasm the process of research may be as uninspiring as it was when the professor confined his original work to his private room or laboratory. Here, as elsewhere, all depends upon the individual; and it is quite possible for a student to prosecute what is called research under an unsympathetic teacher without ever understanding the true spirit of it.

In all the best and most successful developments of higher education a great deal more than this has been done; not only has the success of the applied sciences introduced a new method into their teaching, and made investigation a necessary part of the student's work, but the scientific method has also been communicated like a fever to all branches of learning, and has set them aglow with new activity. It has been discovered that the taste and power for investigation may be acquired by students, and the inspiration of a teacher, who is immersed in research, may communicate a zeal for it to his pupils, that they may become his most valuable assistants, that in them he may build up a school to bring fame to himself and his university, and that his pupils may go out into the world to hand on the lamp of investigation in turn to their followers. When degrees were given for research, and the university seal was set upon investigation as an integral part of a university course, a new chapter was opened in the book of education; and with this advance is bound up the whole system of seminars and advanced courses, which are designed to bring the students into contact with recent discovery and with the original thought of contemporary investigators.

Most British universities now grant certain degrees for research, and it has become the practice to insist upon some evidence of original work or of the power to perform it on the part of the teacher before he is appointed. It is recognised that this will inspire him in the work of instruction. In history, philosophy, science, economics, language, and literature, in almost all the field of educational work, research is demanded; the success of a school is gauged by its output of such work; and the reputation of the teacher is in no small degree measured by the productive activity of his pupils.

So potent is this new force, the spirit of research, in higher education that without it no university teaching is likely to be able to hold its own; the classrooms and the laboratory must be permeated by it if they are to be the scene of successful training. If investigation is not carried on by students, their teachers, at any rate, should be investigators. Let the classics be taught by men who have themselves studied the original manuscripts in foreign libraries, or pursued philological researches; let the professor of history have a first-hand acquaintance, as a worker, with the records that he expounds and the evidence that he describes; let the science professor be one whose name is conspicuous in the journals of the learned societies. The university teaching of ancient history must take account of Minoan civilisation and all the other recent discoveries of the archæologist; the teaching of languages must not disregard the labours of the students of phonetics;

the professor of theology must be familiar with patristic investigation or the modern Higher Criticism; the philosopher, the mathematician, the economist should be themselves active workers who are contributing to the progress of their sciences. Only thus will advanced teaching be conducted in the spirit of living study. There is, or ought to be, no place for the university professor who is not moving with the restless tide of advancing knowledge; who is not himself one of the forces that direct it. To be successful, teaching and research must go on side by side, each drawing vitality from the other. The mere knowledge that the professor or the reader is himself pursuing investigations is enough to stimulate the imagination of the student if he is allowed to see the fruit of those investigations in the work of the lecture or the classroom; how much more stimulating is it if he is himself allowed to take part in his teacher's researches, and if they are made part of his university course!

On the other hand, so exacting are the requirements of modern examinations, and so crowded is the modern curriculum, that there is not always time for this even when the desire is present. For this reason the endowments most required just now are scholarships or fellowships which will enable picked students to remain at their universities two or three years after completing the degree course, and before going out to their work in the world, and to devote those years to research under the direction of their teachers. The universities should be the centres of research in every conceivable subject; nowhere else can the happy union of teaching and investigation be effected. It is not sufficient to endow young men and women, and to leave them free to prosecute their own investigations; in nine instances out of ten they will set to work in the wrong way or on the wrong problem. It is cruel to appoint young teachers fresh from their university examinations, and to expect them to carry on their own researches, and direct the researches of others if they have not themselves had some training therein. But, given teachers who are investigators and students who are endowed and retained for a year or two in order to devote themselves to research under their leadership, the universities will be the oracles from which answers will be sought to the complex riddles of modern life and modern thought; when any new problem arises they will be asked to undertake its investigation.

One more consideration may be urged: it is not only for the properly prepared student that research calls. The inherent interest of original work as compared with routine exercises opens up possibilities in any subject, even for those whose training has been in something quite different. Persons of mature mind whose education has been purely literary, are sometimes able to take up with enthusiasm original research in science under proper guidance without going through the preliminary course; or the scientific student may become, say, an ardent historical investigator. Persons of more than undergraduate age will not desire or be able to go through the complete course of a new subject from its elementary to its final stage, but they can begin at the other end, and enter it by embarking on original work at once under a leader of experience. This view, though it may be highly unorthodox, is based upon my personal experience with advanced pupils, and I know it to be true.

INTERNATIONAL EXHIBITIONS.

A short time ago, Mr. H. Greville Montgomery, M.P., published a pamphlet on "International Exhibitions." Mr. Montgomery's principal object was to discuss the value of such exhibitions to manufacturers, and the consequent desirability of this country taking part in them. Mr. Montgomery criticises the past action of the Government as regards exhibitions, and is strongly in favour of an independent Consultative Committee of Manufacturers, such as has existed for a considerable time in France.

He also remarks that the object of the Government is political, rather than commercial, and that it is consequently hard on individual exhibitors that they should be called upon to represent the country. No doubt there is a certain amount of reason in this argument. But the "political" object of the Government is to advance the industrial and commercial interests of the country, and though it can never be quite certain whether it is to the advantage of an individual manufacturer to exhibit, there can be no question whatever that it is to the general interests of the country that it should be represented at important International Exhibitions. It also appears to be fairly certain that the beneficial results of such exhibitions are not experienced only by the individual who may represent a particular trade, but by the trade in general.

Whether or no individual exhibitors profit by exhibiting is a question difficult, if not impossible, to answer. Men of business are not very keen to give information about their own concerns, and whether an exhibitor has made a profit or not at an exhibition is a matter which he very properly prefers, in most cases, to keep to himself.

Some firms require advertising, others do not. A firm with its hands full of business, which is not anxious to extend that business—supposing such a firm to exist—has no reason for exhibiting any more than it has for advertising. But it is a fair argument that if a firm wishes to advertise it can get as much publicity, at a cheaper rate, by putting up a stall in a good exhibition than it can by advertising in other ways.

Mr. Montgomery objects to the fact that International Exhibitions have now become "pleasure shows and fairs." There is no doubt about this fact. But there is also no doubt that the side-shows alone would not pay without the assistance of the serious

business element. Everyone who knows anything about exhibitions is perfectly well aware that a great majority of the visitors go to the amusements, and for the sake of the amusements. But most of them look at the exhibits as well, and there is also a large proportion of visitors who go solely for the exhibits.

It is probable that the Board of Trade is fairly well conversant with the views of manufacturers, and if they are not, they certainly ought to be. There is no difficulty in ascertaining what those views are without a representative committee being formed. At the same time, it it very probable that such a committee might be useful in this country, as it certainly has been in France.

The question, "does it pay to exhibit?" whether it refers to an individual or to a country, is not easily answered. The committee whose action Mr. Montgomery criticises were inclined to the affirmative answer, and the bulk of the industrial community appears to agree with them.

CHINESE WILD SILK.

M. Francis Marre, writing in *Cosmos*, gives some interesting particulars concerning the wild silk industry of China. A certain quantity of this silk, known under the name "water-eel," is annually imported into France to be worked up in the factories of Lyons and Avignon, but the greater part of it finds its way to America, where it is made into a stuff called "radjab." Of late years, however, a considerable amount has been employed in the manufacture of balloons, a purpose for which it is peculiarly fitted by its strength and toughness.

The silk is obtained from a very common Chinese variety of the oak silkworm (*Antherea Pernyi*). The larva feeds on the leaves of the *Cudrania triloba*, a dwarf oak which grows plentifully on the hills of Ho-Nan, Süchwan and Kweichou. A warm, moist climate prevails almost all the year round in this mountainous district.

The cocoons of the oak silkworm are treated quite differently from those of the domestic silkworm which is fed on mulberry leaves. They are hung in long festoons sheltered from the sun—generally in buffalo-sheds, in order that they may be kept at a constant warm temperature. They remain thus until the Feast of Spring (at the end of January or the beginning of February), when they are removed and hung up in a large room, of which all the doors and windows are carefully stopped. A hole is made in the middle of the roof to allow the escape of the smoke from a stove which is placed in the middle of the room. The stove is kept steadily burning for twenty days; at the end of this period the moths emerge from the cocoons and pairing immediately begins; the males and females are then separated, the latter being placed in palm-leaf baskets, where they lay their eggs. This operation takes about five days. Each female lays on an average some sixty eggs, which are about ten times the size of a mulberry silkworm's egg. After another interval of from fifteen to twenty days, spent in the room which has been closed and heated as before, the worms are hatched and are then taken in the baskets to the places where their food grows. The baskets are set down under the dwarf oaks, the flexible young twigs of which are arranged by the natives so as to make it easy for the worms to climb up to the leaves.

The worm feeds for two months, and then begins to make its cocoon, an operation which takes a week. The cocoons are collected towards the close of May, *i.e.*, from three and a half to four months after the removal from the warm chamber.

The silk is wound and spun in two ways. In the first, which is used to produce a coarse material, the thread is spun from twenty cocoons. Silk of this kind is manufactured almost entirely at Süchwan. In the second the thread is spun from eight cocoons, and silk of this kind, which is made for the most part at Kweichou, is in greater demand for export purposes.

A pound of cocoons produces, as a rule, 240 grammes of fine silk. The average price varies from year to year. In 1907 it was 15 francs the kilogramme; in 1908, 22·6 francs.

THE NORWEGIAN FISHING INDUSTRY.

The Norwegian winter cod fisheries begin, as a general rule, during the first part of January each year, and last until June. These fisheries are conducted along the shores of the central and northern parts of the country, the Lofoten Islands from remote ages having been considered the best grounds. During the season, the fishermen gather at the several fishing stations in these islands from all parts of the north country. With the modern and larger craft now used, many of them provided with motors, the men are enabled to frequent more distant fishing banks, and it has therefore been found more profitable than formerly to fish much further south, where the banks are farther out to sea. The fish are seldom taken more than twenty miles off shore along the Lofoten Islands, and the best catches there are often made only two to three miles from shore. Nets, set lines, and hand lines are used indiscriminately. Some 85,000 men, with 19,000 craft of different kinds and dimensions, are annually engaged in the Norwegian winter cod fisheries. The winter cod is prepared for market by the Norwegians in two different ways, either by what is known to the trade as "stockfish," or else by what is termed "klipfish." The latter, according to the American Consul at Christiania, is known in Latin countries, where both kinds find their best market as "bacalao." In the preparation of stockfish, after the head and entrails have been removed, the fish are strung together in pairs by the tail fins, and hung, unsalted, on horizontal poles resting on beams, placed on uprights, where they are left

until perfectly dried. For klipfish, the head and entrails are removed, the fish split along the belly, and the upper part of the backbone removed. The fish is then salted, and piled in suitable buildings in regular layers, and finally in due course of time, taken out, worked free of surplus salt, and carefully cleaned of black membranes on the belly side, and then cured in places where suitable flat rocks are found convenient for the purpose. Sometimes more than 100,000 fish may be prepared this way in one place, giving employment to a great number of persons—mostly women and children. Klipfish is well known under the general appellation of codfish (salted). Among the by-products of cod are the livers, from which is extracted oil prepared either for medicinal or mechanical purposes, and the roes. The roes are, to some extent, prepared and canned for food, and by far the larger portion is salted in barrels and exported to France and Spain, where they are used at the sardine fisheries. The heads of cod and the backbones of the klipfish are dried and ground for fertilizers. The number of cod and the by-products obtained during the last season were 54,000,000 cod, of which 26,000,000 were prepared as "stockfish," and 24,000,000 as "klipfish," 47,000 barrels of medicinal cod-liver oil, 24,700 barrels of livers for machine oils, and 41,900 barrels of roes. The prices paid to the fishermen vary considerably, according to time and place. The average catch at the Norwegian cod fisheries for a period of forty-two years covered by statistical reports is 50,700,000 codfish per annum, and this figure was reached in 1909 for the first time since the year 1897.

SECOND INTERNATIONAL FOOD CONGRESS.

This year's Congress, just held in Paris, was devoted to the definitions of such operations as might be recognised in the manufacture of alimentary substances.

In passing, it may be said, that when these definitions are complete, they will form a guide of an irreproachable character to all who are concerned in the production or handling of food and alimentary substances. It will not be possible, however, to translate into law the various findings until analytical methods are unified, and a complete system of standardisation has been set up in every country—a task to which next year's Congress will probably be devoted.

The Congress this year was held in the College of Medicine, Paris, which was kindly given up by the Faculty to its deliberations, during the week (October 17th to 24th).

Over 2,000 members subscribed their names, and they hailed from 28 different countries throughout the world. The official opening took place on Monday, the 18th October, and was presided over by M. Ruau, the distinguished Minister of Agriculture of France.

The various food and alimentary substances were grouped together under general headings, which formed the designations of sections, and the order of procedure was as follows:—

Each subject was discussed and a definition arrived at by a vote. This definition, or resolution, was considered to be the finding of the Section, and was thereafter referred to the Hygienic Section, which discussed the matter from the point of view of Health and Hygiene.

The Sections were as follows:—I. Drinks, including wine, liqueurs, cider, beer, syrup, and vinegar. II. Bakery Products, including flour, bread and pastry. III. Confectionery, including sugar, honey, cocoa, and chocolate. IV. Grocery and Spices, including tea, coffee, mustard, and salt. V. Dairy Produce, including milk, cream, condensed milk, butter, cheese, and eggs. VI. Meat Industry, as also oils, edible fats, bacon curing, sausages, preserved fruits, and vegetables. VII. Drugs, essential oils, chemical products, mineral waters, and ice.

In all these sections there were continuous discussions until resolutions were arrived at, and the results will be published in Proceedings ("Compte Rendu") in due course, and this will form a complete book of reference on the sophistications of food, and the limits to which they will be tolerated in all countries.

Some of the findings of the Congress were very notable. Thus—in connection with wines, it was decided that while pure wine could only be described as the product of the complete, or incomplete, fermentation of the juice of fresh grapes, it would appear that the manipulations are many and various, and that the addition of foreign substances, such as sulphurous acid, and pure alcohol derived from malt, are allowable. In connection with fruits also, sulphurous acid is deemed a necessary addition.

One of the most important discussions took place concerning dairy produce and the use of preservative in butter and other produce. It was decreed that "Boron preservatives" were not only allowable, but were absolutely necessary in the manufacture of butter. It was also held that the addition of such a preservative should not require to be declared in future, any more than the presence of salt would have to be declared, and thus the addition of preservatives would be reduced to the regular operations recognised as being essential to the good conduct of the butter industry. It was also decreed that the standard water contents of butter should be raised from 16 to 18 per cent.

Coffee was clearly defined as being an article of produce without the addition of any foreign matter, from the coffee bean in its entirety, and the addition of chicory in any shape or form, and the extraction of caffeine, were declared to be sophistications, and were prohibited.

Milk, again, was considered to be only worthy of

the name when derived from a healthy cow and could only be regarded as pure when it did not contain any added matter whatever. The subtraction also of any portion of the fat was regarded as being an irregular operation. Pasteurisation, filtration, and refrigeration were regarded as regular operations; but sterilisation, creaming, and homogenisation were declared to be facultative operations, which should be announced at the time of sale.

In connection with drugs, much discussion took place, and a very interesting brochure was presented by the English delegation, which occupied a large part of the discussions. The result may be the appointment of an International Commission to investigate the matter more fully.

Cocoa and chocolate attracted much attention, and there was a long battle between small producers and large capitalists as to what may be tolerated in cocoa. The small producers wanted the use of alkali to be recognised, inasmuch as they contended that, while its use enabled them to produce a cheaper commodity, they also sold the cocoa at a cheaper price than the large manufacturers, and consequently they supplied a great section of the public who could not afford to pay the high prices asked for by the few large manufacturers. Subsequently it was declared that the use of alkali in cocoa manufacture should be tolerated, but that the whole question should also be submitted to an International Commission.

In connection with confectionery it was decided that the use of some 20 aniline colours should be allowed, and ice for alimentary use was defined as being of two kinds—manufactured and artificial. It could be only considered pure when it was manufactured from either sterilised or towns' water, and natural ice should be handled under such conditions as should prevent any exterior contamination, and should be under permanent sanitary control. The use of any other kind of ice for beverages, or in connection with food was prohibited.

These brief references to the decisions arrived at, will serve to indicate the kind of work done, and will also illustrate the fact that the various discussions were taken part in by men who were thoroughly competent to come to a decision on the various matters submitted to them.

One thing was very noticeable, namely, that it became plainer and plainer as the Congress progressed that there was hardly a substance in connection with the food supply, which was not subjected to some kind of sophistication or adulteration, and it became evident also, that if the means could be devised to prevent frauds in foods, it would be an immense gain to every nation, inasmuch as it appeared to be quite common in some industries to employ skilled chemists with a view to reducing the quality of the food, while preserving their external appearance, and that frauds of this kind are daily perpetrated. This more especially affects the poor, who are not in a position to judge of the purity of their food, or to control it in any way.

HOME INDUSTRIES.

The Agricultural Outlook.—With wheat at from 40s. to 43s. a quarter, and probabilities pointing to higher prices, farmers are beginning to ask themselves whether they may not put land now laid down to indifferent grass under the plough again. A few years ago it was assumed that, for many generations at least, the Western States of America would be the chief granary of Great Britain. It was argued that, with at least equal energy and skill, with a climate and soil better adapted to wheat-growing, with an ever increasing supply of labour, and with ever multiplying channels of transport, Western farmers of English race could scarcely fail, ere long, to maintain the same lead in the markets of Europe, as English manufacturers, but for a protective tariff, would be able to maintain in those of America. But sufficient allowance was not made for the rapid growth of population in America. Already the United States have ceased to be the largest exporters of wheat to the United Kingdom; before many years have gone they will cease to be exporters of grain, and before another generation has passed the United States may be buying wheat from Canada to feed their own people. Argentina has now become our chief granary, but there is a tendency in the Argentine to displace wheat with cattle. India sends us large quantities of wheat, but the supply is subject to great variations, and the home consumption grows apace. To make up the deficiency from elsewhere we must look to Canada and Siberia. The potentialities of Canada in this direction are great, but she will hardly do more than repair the decline in the exports from the United States, and cannot do that for many years to come. The wheat production of Siberia is increasing, but the increase is not likely to be very rapid in the immediate future, and meantime the demand is not only increasing in Europe, but in Asia, not only in England and in Germany, but in Japan and in India. It is reasonably safe then to assume that the days of very low prices for wheat have passed, and that farmers may now rely upon the prices of all kinds of grain reaching, and remaining at, a level that will give a fair profit, and a larger one than can now be got from some of the poor grass land. It must not be forgotten in considering possible profits of grain growing in this country that the cost of production is considerably less than it was in what are looked back upon as the halcyon days of agriculture. The self-binder has greatly reduced the cost of harvesting, and in other directions savings have been effected. Wheat with an average crop of four quarters—last year the average was 32·16 bushels—per acre means with the price at 40s. per quarter, £8 per acre, and that of itself leaves a profit. Much too might be done in many directions, and something is already being done, by means of co-operation. In olden times, however low might be the price of wheat, the farmer got the whole, or nearly the whole of it, but now-a-days a large army of middlemen has sprung up, and

a toll is exacted at every stage in the process whereby the national food supplies are brought within the consumer's reach. An extensive application of the co-operative principle to the distribution of farm produce, if not to agriculture itself, may prove to be one solution of the agricultural problem. However that may be, the prospects of agriculture, resting as they necessarily must largely upon prices, are brighter just now than they have been at any time since the middle seventies.

Private Banks—The amalgamation of Stuckey's Banking Company with Parr's Bank deprives the country of one of its few remaining great private bank institutions. Founded at Langport, Somerset, nearly two hundred years ago by Samuel Stuckey, a purely local bank for Gloucester and Somerset, its career has been one of uneventful prosperity. Its head office has remained at Langport, a town of some 2,000 inhabitants, but it holds nearly £7,000,000 of deposits, and it has a larger note circulation than any other bank except the Bank of England. The business of Stuckey's was built up by the gradual and steady opening of branches at places in the west country where banks were wanted, and the number of its branches is now 71. Since 1880 its business has nearly doubled if the amount of deposits may be taken as a guide, and it might have been thought that its controllers would have preferred to continue the separate control of the bank. Parr's was also originally a private bank carried on by Messrs. Parr and Co. of Warrington, but unlike Stuckey's its progress since it took over Messrs. Parr's business in 1865 has been largely due to amalgamations. In its first report it announced that the business of Messrs. Thomas Firth and Son, at Northwich, had been acquired, and since then its amalgamations have been continuous. Among them may be named the Metropolitan and Provincial Bank of Macclesfield; the Wigan Old Bank, Wigan; F. W. Jennings, Leek; Fuller, Banbury Nix and Co., London; Alliance Bank, London; Sir Samuel Scott and Co., London; Shrubsole and Co., Kingston-on-Thames; Croxon, Jones, and Co., Oswestry; Dumbell's Banking Company, Isle of Man; Robin Brothers, Jersey; and many others. At the end of last year its offices amounted to 185, and its amalgamation with Stuckey's leaves it with only six joint-stock banks ahead of it in the amount of its current deposit and other accounts. It is with something more than sentimental regret that many, more especially West country folk, will hear of the absorption of Stuckey's. The rapid disappearance of the private banks is by no means an unmixed gain to the community, but it is inevitable.

Why they are Disappearing.—The disappearance of Stuckey's as an independent organisation recalls Mr. Walter Bagehot and his views upon the future of the private banks. The great uncle of Mr. Bagehot, Samuel Stuckey, founded this bank of which his father, Thomas Bagehot, was for thirty years the controller. For several years Mr. Bagehot himself was manager of local branches of Stuckey's Bank, and on leaving the West of England he supervised the bank's London business. Naturally Mr. Bagehot looked favourably upon the private bank, but five and forty years ago he predicted that the days of small banks would before many years come to an end, and that the difficulties of large private banks are very important. In 1810 there were 40 private banks in Lombard-street admitted to the clearing house—there now is only one, nor is the race renewed. Everybody admits that you cannot found a new private bank. The old ones merge or die, and so the number is lessened, but no new ones begin to increase the number again. No new private bank is founded in England because men of first-rate wealth will not found one, and men not of absolutely first-rate wealth cannot. As Mr. Bagehot points out, in "Lombard-street," in old times the private banks were without rivals. The Bank of England had a monopoly in banking of the principle of association. But now large joint stock banks of deposit appeal to the public. They have a large paid-up capital and intelligible published accounts, and they use them as an incessant advertisement, in a manner in which no individual can use his own wealth. In the business of banking there is an enormous growth of detail. Now-a-days bankers not only keep people's money, but also collect their incomes for them, and the private banker has not the organisation that enables him effectively to carry on this new, ever-expanding, and exacting business.

The Whisky Industry.—In the last ten years, the Scotch whisky trade has been struggling with the consequences of reckless production. Stocks were piled up, so that in the financial years, 1897-8 and 1898-9, no less than 26,000,000 gallons were added to the stocks, and in 1904-5 the total stocks in Scottish bonded warehouses aggregated 121,778,000 gallons. During the past financial year, while the production of home-made spirits in Scotland was increased by 1,611,172 proof gallons, the stocks in bond showed a further decline of 1,460,713 proof gallons, but at the latest date for which the official figures are available, the stock remaining in bonded warehouses amounted to 114,188,000 gallons. The falling-off during the last four years, although varying from 1,264000 gallons to 3,328,000 gallons has been very slight when the immense volume of the stocks is considered, and even without the extra duty imposed by the Budget it must have been a long time before the position could be described as a healthy one. As it is, the imposition of the additional duty of 3s. 9d. per gallon on home-made spirits has been very prejudicial to the trade. The Chancellor of the Exhequer admits that he greatly under-rated the effect of the additional duty upon consumption. The imposition of large additional burdens on a falling industry make it probable that less rather than more will be got out of the tax,

and this has happened with the whisky duty. Consolation may be found in the decrease of crime consequent upon the great fall in the consumption of spirits, but from the point of view of the trade the additional duty has greatly worsened the position.

The Change in the Excise Duties.—Many exaggerated statements have been made with regard to the changes in the license duties that will be effected by the present Budget if it becomes law, but it is apparent that the new scale of duties if finally adopted will greatly lessen inequalities in taxation which are indefensible in themselves and unjust to the small public houses. Under the existing system, while the duties levied on houses of less than £100 annual value represent a ratio of from 53 to 60 per cent. of the mean rateable value, the ratio rapidly declines until, in the case of houses rated at between £2,000 and £5,000 per annum the duties represent no more than 2·7 to 1·3 per cent. of the mean rateable value. Mr. J. E. Allen has given an admirable illustration of the anomalous results of the present scale by pointing out that 100 houses rated at £16 pay £800; 10 houses rated at £160 pay £300; one house rated at £1,600 pays £60. The present proposals go a long way to equalise duties.

CORRESPONDENCE.

BURIED TOADS.

With reference to your note on toads in the Society's *Journal* of the 8th inst., in the course of which you say, "Put him in a dry place and he shrivels up at once," it may be of interest to relate what came under my personal observation a few years ago.

When on duty in the lines one day at Aldershot, I was called over to see a toad which had been cut out of a lump of moss litter. He was in a large, nuggety lump, which had separated out from the bale on breaking it up. This toad was, I think, "made in Germany," and must have been subjected to very great pressure in the wire-bound bale of dry moss litter. He was quite healthy apparently, and I carried him to the canal bank, where I released him.

H. COTTINGHAM.

Halifax, N.S.,
October 20, 1909.

NOTES ON BOOKS.

CATTLE OF SOUTHERN INDIA. By Lieut.-Colonel Gunn, Superintendent Indian Civil Veterinary Department, Madras, 1909. Price Rs. 3.

The "Report on the Material and Moral Progress of India," written by Sir Clements Markham in "the seventies," still holds its own, for well selected, comprehensive, accurate, and profitable information, and above all, for inspiration, as "a Model Blue-Book," for so it was, on its publication, at once entitled by the *Saturday Review*: and the aptest praise that can be accorded to Lieut.-Colonel Gunn's "Report on the Cattle of Southern India" is to say that it deserves to be placed among one's books of reference, beside Sir Clements Markham's "Blue-Book," and Professor Wallace's "India in 1887," as the "Model Bulletin," No. 60 of its series, issued down to this date by the Department of Agriculture of the Government of Madras. It is worthy indeed of comparison with some of Surgeon Buchanan Hamilton's MS. Reports on the Agriculture of Southern India [Malabar, Kanara, and Mysore].

Colonel Gunn deals exhaustively with the technical side of his subject. Excluding the innumerable "lesser breeds without the law" of unnatural selection, there are six great breeds of artificial, or human production to be clearly recognised among the cattle of Southern India; and of these the two chief are those distinguished all over India by the names of "Mysore," and "Ongole"—from a town of the Nellore District. Of all six breeds, and their varieties, full descriptions are given, so detailed, precise, and graphic, that they are quite independent, for the purpose of identifying the originals, of the excellent photographs, 60 in number, that but serve to emphasise the accuracy and vividness of the written specifications of the several types of bulls, milch-cows, and oxen so illustrated; and this is the proper utility of the photograph in such works; in which it should never usurp the place of the letter press, wherein their quickening spirit should first be found.

But Colonel Gunn does not limit himself to an exclusively technical view of the cattle of the Madras Presidency; he tells us also of their agricultural history, and even of their national and political history; and it is this part of his Report that will interest all its readers. As my space is limited it is impossible to refer here to more than his history of the celebrated "Mysore" cattle. They are not so beautiful of form and feature as the statuesque and docile "Ongoles," that might well have provided the model for Myron's "Heifer," in praise of which the Greek "Anthology" has preserved 36 epigrams [Pliny xxxiv. 19 (8)]. But they are more compactly built, and are very strong, and high-spirited, and sound and hard, and fleet of foot, and are especially adapted to roadwork, either for slight draughts or pack loads; the Ongole cattle being more suitable for heavy, and slow, and steady draught work. The "Mysores" of the very highest lineage are named "Amrat Mahal," literally "the Palace of the Immortal drink (compare nectar) of the gods," but in this connection meaning "pails of milk:" and these "Amrat Mahals" are divided into two classes, the "Dodadhana," literally "Strong-bows," and the "Nadudhana," literally "Dwarfed-bows." The herds, or *serwes*, of Amrat Mahals accumulated in Mysore during centuries of Hindu rule, were all seized by Hyder Ali when he over-

ran the Deccan in 1761, but he allowed them to be scattered, and degenerate. His son, Tippu Sultan, however, again brought the herds under State control; and instituted markets for their sale, attending them himself for the purpose of presenting prizes to the finest beasts of the year. Under his patronage the "Mysores" rapidly regained their pristine prestige, and it was thanks to their strong backs and nimble legs that he was able in 1783 to cross the peninsula of India in one month for the recovery of Bednore. They also enabled the Duke of Wellington to execute his marches of unexampled rapidity in India that are to this day the admiration of military men; and they gained for the Bombay Army the credit it required for its superlative commissariat arrangements under Captain Davidson, in the Afghan war of 1842. In 1860 Sir Charles Trevelyan, the destroyer of the Indian navy, to the destruction of which we owe the decline of our influence in Persia during the past fifty years, ordered the grazing grounds, or *kavals*, of the "Amrat Mahals" to be broken up, and the herds dispersed, with again the most fatal results to the public interests. Fortunately, before it was too late, the Government of India reorganised these establishments, although with some difficulty, as it was found that the bulls and cows of the best blood had been purchased between 1860 and 1866 by the prescient Khedive of Egypt, Ismail Pasha. At the present date the condition and number of the "Mysores" of both pedigrees are far in advance of all previous authentic records, and their names and fames never stood higher in India.

The bull and the cow are intimately associated with the religion of India, as with all the religions of antiquity, of which Hinduism is a still living survival; and also with the folk lore of the Hindus. But space again does not admit of any adequate references to these particulars of Colonel Gunn's report in this place. But it is of moment to note that the presence of so many ill-conditioned bulls and cows in India is not due to any neglect of them, as ignorant Europeans are repeatedly found stating, but simply to the mistaken piety that makes it impossible for a Hindu to kill cattle incapacitated for work, by accident, disease, or old age. They are therefore given a free run of the grazing grounds, and grain dealers' stalls, with the cattle still in "active service." This may tend theoretically, but I think scarcely practically, to the deterioration of high graded breeds, but it is no more cruelty than is providing, as we now do in this country, for the unemployable, as well as unemployed, and giving old-age pensions to poor people on their reaching the age of seventy,—instead of their euthanising us all! The household cow is fed of a morning before her master and his family; and an oath by "the tail of a cow," *gaudivya*, is as appealingly, and appallingly binding on a Hindu, as the oath "by the head of a son" was on the ancient Romans [Pliny the Younger II, 20, and Martial XI, 94], and is still on the modern Persians—the Parsis—of Bombay. Speech is personified by the Hindus in the name of the goddess Vach, the Latin "vacca," and "vox," &c., and the English vowel, advowson, &c., and the Hindustani *bhasha* is but a variant of the word. The Sanskrit appears in the Greek γαῖα, "earth," and the goddess "Earth," and βοῦς, "cow," "bull," and "ox," *gau*, "cow," "bull" [or ox], and in composition "Earth," as in *gauchana*, "a wheat field," re- and in the English "cow," Scotice *coo* [the English word, ox, has been identified with the Sanskrit *akshan*]. Finally, the Indian land measure *gauvada*, or *gaukos*, means literally the distance the lowing of "a cow reaches," and *gaucharma*, as much land as can be included within a cow-hide cut into strips [compare our words "hide," and "plow" in their similar significances]: and the linear measure, *gaukarna*, used by Hindu handicraftsmen, literally means the length of "a cow's ear." All this indicates the immeasurable, the abysmal antiquity of the knowledge, the use, and the worship of the cow and the bull among the Indo-Aryan races from long before they divided into Persians, Hindus, Celts, Germans, and Slaves; a process Sir Henry Rawlinson calculated to have extended over at least 50,000 years. To the artistic eye, one of the most beautiful sights—visions—in India, is that of some huge, milk-white "Ongole" lounging about the bazaars with a long chain of huge turquoise blue enamelled beads hanging about its neck. Their colour symbolises the purity. and holiness of the beautiful creature; and thus connects these necklaces with the Forget-me-not, and the blue Iris, and the blue Lotus of Egypt, and the sapphire, called by the Greeks "Truth," and with the "Blue Ribbon of the Garter,"—the garter of Joan Countess of Salisbury; and again with the "blue ribbon" of our modern "total abstainers."

GEORGE BIRDWOOD.

THE OLD AND THE NEW PERU. By Marie Robinson Wright. Philadelphia: George Barrie and Sons; London: C. D. Cazenove and Son. £2 2s.

After many years of travel and residence in this land of romance, Mrs. Wright has set herself to describe "the most interesting of all the South American countries." Let it be said at once that she has succeeded in writing a most fascinating and popular account, which, if it does not, perhaps, contain much material that is new, certainly sets forth in an exceedingly readable and attractive style most of the information about Peru that will prove of service to the general reader. To begin with, she gives what she calls "a passing glimpse of the old Peru;" and if, as she adds, the whole story can only be told in many volumes, she certainly contrives with the aid of some excellent illustrations to give a very suggestive idea of the wonderful ruins of Pachacámac, of the palace of Chan-Chan, with its elaborately carved walls and terraces, and of the buildings

of Cuzco, whose great stones are so cunningly cut and laid that they are still the wonder of the architect. Proceeding, she gives in brief the history of the country, from the Spanish conquest of Pizarro, whose daring was only equalled by his perfidy; of the fate of the unhappy Atahuallpa and the overthrow of the Inca dynasty, and the dark centuries of Spanish misrule. After this short but adequate historical *résumé* she goes on to describe "the progress and development that are evident in every feature of the national life as reflected in the social, political, industrial and commercial institutions of the New Peru." It is impossible to note more than a few of the points on which she touches. Her descriptions of the scenery, scattered at random throughout the volume, are excellent. "Tradition says, that when Maita-Ccapac first led his army across the Apurimac river, some of the soldiers were so enchanted with the attractions of the country, especially the picturesque valley above which the snowy summit of the Misti glistens among the clouds, that they asked the Inca's permission to remain. 'Ari, Quepay!' responded their lord, 'Very well,—Remain here!' and from this exclamation is derived the name of the beautiful city that now brightens the valley at the foot of the Misti—Arequipa."

The natural resources of the country would seem to be boundless. Apart from the immense mineral wealth which still lies buried in the Andes, Peru contains vast tracts eminently suitable for agricultural and pastoral development, while the value of the forests can scarcely be guessed at. Guano—which one might almost call a by-product of the country—between the years 1840 and 1867 brought to the Peruvian treasury the enormous sum of two hundred and twenty million dollars. "Every financial difficulty that arose at that time was met by mortgaging the future returns from the sale of guano; and Peru, counting on the extraordinary and abundant return from this source, met all the demands of the Government without recourse to taxation—a condition unheard of elsewhere in the financial history of the world."

How is it, then, that with all these natural advantages Peru has not made greater strides in wealth and progress? The answer is the Andes, which, while they are indirectly the cause of most of Peru's wealth, at the same time render it almost inaccessible. Some idea of the difficulties of transport may be gathered from Mrs. Wright's statement that Deputies from Iquitos, on the Amazon, travel to Lima, on the Pacific, by way of Europe and Panama, rather than cross their own country, as the foreign trip takes less time. But this state of things will be soon improved. Already the Oroya Railway, the highest in the world, has been pushed across the Andes; a second ascends 14,660 feet as far as Arequipa and Lake Titicaca, and others are now under construction. "The prosperous future of Peru," says Mrs. Wright, "is assured by the patriotism, energy, and enterprise that are apparent in every feature of the national life, and it is certain that the present century will see the wealth and greatness of the country increased beyond anything dreamed of in the days of the Incas and the viceroys."

FORENSIC CHEMISTRY AND CHEMICAL EVIDENCE. By William Jago. London: Stevens and Haynes. 5s. net.

A short time ago Mr. Jago delivered a course of lectures at University College, London, on "Forensic Chemistry," with special reference to chemical evidence, its preparation and adduction. Mr. Jago is both a chemist and a barrister-at-law, and he is, therefore, exceptionally well qualified to understand the difficulties which beset the members of the two professions when questions relating to chemical evidence come before the Courts. The lectures have been republished in their present amplified form at the request of a number of lawyers and chemists, and the book should certainly prove of great assistance to those who have to deal with chemical evidence. It appears to treat the subject in a very clear and complete manner, discussing such questions as the adulteration of food and drugs, the use of preservatives and colouring matters, and chemical evidence both in civil and criminal cases, and embodying the most important judicial decisions on the various points raised.

THE GROWTH OF THE ENGLISH HOUSE. By J. Alfred Gotch, F.S.A., F.R.I.B.A. London: B. T. Batsford. 7s. 6d. net.

The object of this book is to give a short history of the architectural development of the English house from 1100 to 1800, "from its first appearance in a permanent form down to the time of our grandfathers, when it lost much of its interest." The author has during many years made the subject of domestic architecture the study of his leisure time, and in his previous works, "The Architecture of the Renaissance in England" and "Early Renaissance Architecture in England," he has shown that he not only possesses a great knowledge of his subject, but that he can express himself in a simple yet scholarly style. In the present volume the arrangement is chronological; starting with a description of the Norman Keep, Mr. Gotch proceeds to deal with the fortified manor house of the thirteenth century, in which the chief feature is the dominance of the hall, the later manor house of the Middle Ages, the Italian influence which made itself felt in the early sixteenth century, and so on through the Elizabethan and Jacobean periods to the late seventeenth and early eighteenth centuries. In this way the steps in the gradual evolution of the English house are clearly traced, and a careful study of the book should (as its author hopes it will) enhance the pleasure of cultivated people in visiting the ancient homes of their country by enabling them to differentiate one style from another, and "to connect the various buildings with their appropriate phases of history. The numerous illustrations have been carefully selected, and are admirably reproduced.

GENERAL NOTES.

ROYAL INSTITUTION.—The 84th Christmas Course of Juvenile Lectures, founded at the Royal Institution in 1826 by Michael Faraday, will be delivered this year by Mr. William Duddell, F.R.S., his subject being "Modern Electricity." The course, which will be experimentally illustrated, commences on Tuesday, December 28, at three o'clock, and will be continued on December 30, 1909, January 1, 4, 6, and 8, 1910.

THE ILLUMINATING ENGINEERING SOCIETY.—The opening meeting of this Society will take place on Thursday, November 18th, at 8 p.m., at the House of the Royal Society of Arts (18, John-street, Adelphi, London, W.C.), when a brief report of the progress of the Society will be presented by the Hon. Secretary, and the inaugural address will be delivered by Prof. Sylvanus P. Thompson, D.Sc., F.R.S., the first President of the Society.

PUZZLE POSTCARDS.—The latest development of the picture postcard is the puzzle postcard, published by Messrs. Raphael Tuck and Sons. It consists of a stoutish envelope of cardboard which, on being opened, is found to contain a picture postcard and a puzzle picture of the scene displayed on the post-card, dissected into some thirty pieces. Various games may be played with these puzzles, the object generally being to see who can complete the largest number of designs in the least time. They should find a ready sale, among the young people, at Christmas time, when they will help to shorten a long evening.

AFFORESTATION IN ITALY.—A report has just been issued by the Italian Secretary of Agriculture on the work of afforestation which has been carried on in Italy during the last forty years. The Government are keenly aware of the value of forests, and are determined to reafforest, as soon as possible, the lands which were stripped of trees when the forests ceased to be protected. One hundred and twenty-two thousand acres of Government land have been planted, of which 69,000 acres, or approximately 108 square miles, were planted in 1907 alone, involving an outlay of nearly two million dollars, and providing employment for a large number of men. Reafforestation has been carried on with such energy that there now remain only about 36,000 acres of Government land in need of planting. During the period under review, the Italian Government, in addition to conducting planting operations on a large scale, have distributed over 130,000,000 young trees and 237,000 lbs. of seed in order to encourage planting and sowing by private individuals.

SANITATION IN TROPICAL AFRICA.—In accordance with the recommendations of the recent departmental committee on the West African Medical Staff, the Secretary of State for the Colonies has appointed the following gentlemen to be an advisory committee on medical and sanitary questions connected with the British Colonies and Protectorates in Tropical Africa:—Mr. H. J. Read, C.M.G., of the Colonial Office (chairman); Sir Patrick Manson, K.C.M.G., M.D., M.R.C.P., F.R.S., senior lecturer, London School of Tropical Medicine; Sir Rubert Boyce, M.D., F.R.S., dean of the Liverpool School of Tropical Medicine; Mr. C. Strachey, of the Colonial Office; Mr. W. T. Prout, C.M.G., M.B., late Principal Medical Officer, Sierra Leone; Mr. Theodore Thomson, C.M.G., M.D., of the Local Government Board; Mr. W. J. Simpson, C.M.G., M.D., F.R.C.P., Professor of Hygiene, King's College, London; Mr. J. K. Fowler, M.A., M.D., D.Sc., F.R.C.P., late Dean of the Faculty of Medicine, University of London. Mr. A. Fiddian, of the Colonial Office, will act as secretary to the committee.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 8... Surveyors, 12, Great George-street, S.W., 8 p.m. Opening Address by the President, Mr. Alexander Rose Stenning.

Geographical, Burlington-gardens, W., 8½ p.m. Mr. Claude White, "Two Journeys in Bhutan."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. S. L. Hughes, "Candidate, Member, and Ex-Member."

Cold Storage and Ice Association (in the ROOMS OF THE ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.), 8 p.m. Discussion on "A System of Units for the Refrigerating Industry."

TUESDAY, Nov. 9...Asiatic, 22, Albemarle-street, W., 4 p.m. Dr. G. A. Grierson, "The Beloved of the Adorable."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Messrs. J. Dalziel and J. Sayers, "The Single-Phase Electrification of the Heysham, Morecambe and Lancaster Branch of the Midland Railway." 2. Mr. Joshua Shaw, "The Equipment and Working-Results of the Mersey Railway under Steam and Electric Traction." 3. Dr. Charles Augustus Harrison, "The Effect of Electrical Operation on the Permanent-Way Maintenance of Railways as Illustrated on the Tynemouth Branches of the North-Eastern Railway."

WEDNESDAY, Nov. 10...United Service Institution, S.W., 5 p.m. Mr. Douglas Owen, "Our Food Supplies in Time of War."

Sanitary Institute, 90, Buckingham Palace-road, S.W., 8 p.m., Discussion on "The Quality of Effluents in Relation to Standards."

THURSDAY, Nov. 11...London Institution, Finsbury-circus, E.C., 6 p.m. Mr. C. J. Sharp, "English Folk Singers and their Songs."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Inaugural Address by the President, Dr. Gisbert Kapp.

FRIDAY, Nov. 12...Physical, Imperial College of Science, South Kensington, S.W., 8 p.m. 1. Mr. P. V. Bevan, "The Absorption Spectrum of Potassium Vapour." 2. J. S. Dow, "Some Further Notes on the Physiological Principles Underlying the Flicker Photometer." 3. Dr. F. W. Edridge-Green, "Exhibition of a Colour Perception Spectrometer." 4. Mr. H. G. Savidge, "Tables of Ber and Bei and Ker and Kei Functions, with Further Formulæ for their Computation."

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FRIDAY, NOVEMBER 12, 1909.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

ARRANGEMENTS FOR THE SESSION.

The Opening Meeting of the One-Hundred-and-Fifty-Sixth Session will be held on Wednesday evening, the 17th of November, at 8 p.m., when an address will be delivered by SIR WILLIAM H. WHITE, K.C.B., LL.D., F.R.S., Vice-President, and Chairman of the Council. The subject of the address will be "An Imperial Navy."

The following arrangements have been made for meetings previous to Christmas :—

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock :—

NOVEMBER 24.—T. THORNE BAKER, F.R.P.S., "Photo-Telegraphy."

DECEMBER 1.—HON. RICHARD C. PARSONS, M.A., "Resilient Wheels for Vehicles." SIR JOHN WOLFE-BARRY, K.C.B., F.R.S., will preside.

DECEMBER 8.—JAMES BUCKLAND, "The Destruction of Plumage Birds."

DECEMBER 15.—H. PEARSON, "The Diamond Fields of Brazil."

COLONIAL SECTION.

Tuesday afternoon, at 4.30 o'clock :—

NOVEMBER 30. — SAMUEL SIMPSON, B.Sc., M.R.A.S.E., "Agricultural Development in Nyasaland." SIR HARRY H. JOHNSTON, G.C.M.G., K.C.B., D.Sc., will preside.

INDIAN SECTION.

Thursday afternoon, at 4.30 o'clock :—

DECEMBER 9.—SIR JAMES WILSON, K.C.S.I., "The Punjab."

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

CHARLES CYRIL TURNER, "Aeronautics." Four Lectures.

LECTURE I.—NOV. 29—Aerostats and aeronefs—Ballooning and its future—Possible lines of development—Kites—Birds—Is flapping wing flight imitable?—Soaring flight—Gliding flight—Action of the air on plane and curved surfaces—The leading or "entering" edge—Aspect ratio—The inclined plane—The curved plane — The concavo-convex plane — The gliding angle—Air resistance—Stream-line form—The atmosphere — Different qualities of air—Air propellers.

LECTURE II.—DEC. 6.—Dirigible balloons—Comparative efficiency of different types—The elevator—The ballonnet—The compartment system—Methods of suspension—Stability—Motors and propellers—The ascent and the landing—Harbours—Capacity and utility of dirigible balloons.

LECTURE III. — DEC. 13. — Aeroplanes, helicopters, and ornithopters — Present failure of the two latter—The simple glider—Principles of stability.—The question of automatic stability—The relation of speed to stability—Various methods of obtaining stability — The compartment system — Adjustable planes—Flexible planes—Some suggestions—Starting and alighting—Position of the pilot.

LECTURE IV.—DEC. 20.—Flying-machine motors and propellers—Specialised flying-machines—Differentiation of type—Limitations—Practical results—Uses of the flying-machine—Navigation of the air—Flying by night—Special maps and landmarks—Possibilities in war.

Papers to be read after Christmas :—

H. S. SMITH, "Oxy-Acetylene Welding."

E. COOKE, "The Teaching of Design."

CHARLES JOHN STEWART (Public Trustee), "The Public Trustee and his Work."

CYRIL DAVENPORT, "Miniatures."

KENNETH GRAY, "Heating and Ventilation."

OMAR RAMSDEN, "Goldsmiths' and Silversmiths' Work."

C. G. ZANDER, "Printing Inks."

SYDNEY PERKS, F.R.I.B.A., F.S.A., "The Guildhall: the recent discoveries and restoration."

E. B. HAVELL, late Superintendent Calcutta School of Art and Art Gallery, "Art Administration in India."

GEORGE OWEN DUNN, M.Inst.C.E., Chairman, Bombay City Improvement Trust, 1904-1909, "The Bombay Housing Question."

SIR RICHARD CARNAC TEMPLE, Bart., C.I.E., "The People of Burma."

DR. JOHN MCCALL, Agent-General for Tasmania, "Fruit Production in the British Empire."

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

January 13, February 17, March 10, April 21 May 26.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

February 1, March 1, May 3.

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

ALAN S. COLE, C.B., "Textile Ornamentation." Three Lectures.

January 17, 24, 31.

PROFESSOR W. WATSON, D.Sc., F.R.S., "The Petrol Motor." Four Lectures.

February 7, 14, 21, 28.

LAWRENCE WEAVER, F.S.A., "Lead Work." Two Lectures.

March 7, 14.

ALFRED B. SEARLE, M.S.C.I., "Modern Methods of Brick-making." Four Lectures.

April 11, 18, 25, May 2.

JUVENILE LECTURES.

Wednesday evenings, January 5 and 12, 1910, at 5 o'clock:—

PROFESSOR HAROLD B. DIXON, M.A., F.R.S., "The Chemistry of Flame." Two Lectures.

THE DEPARTMENT OF LEATHER INDUSTRIES, UNIVERSITY OF LEEDS.

The city and district of Leeds have long been one of the chief centres of leather manufacture in the United Kingdom, and this fact naturally suggested the idea that a department for the technical study of the subject should be established to do for the trade what the Yorkshire College had done for the engineering, textile and dyeing industries of the West Riding. Accordingly in 1890, after consultation with the leading tanners, a report was drawn up containing definite proposals for the purpose, which were approved in substance both by the Council of the College and by the Leeds Association of the Leather Trade, and somewhat later by the Court of the Worshipful Company of Skinners, who were approached on the subject as the proposal took definite form. As a beginning, the present Professor, Mr. H. R. Procter, who was at that time chemist to an extensive leather works, and who had previously had many years of practical experience in the trade, and was already favourably known as a writer on its technology, was appointed lecturer. In the spring of 1891, in company with a small deputation representing the Yorkshire College and the Leeds Association of the Leather Trade, he visited the leading Continental tanning schools at Vienna and Freiberg in Saxony, and the Technical High School at Berlin, to study their arrangements and methods of teaching. With the knowledge thus gained, a laboratory was at once fitted up at the college, and a course of lectures arranged for the following session, the expenses being met by contributions from the Skinners' Company and from members of the Leeds Association of the Leather Trade.

The department opened with an attendance of nine day students, and a considerable evening class. From that time to the present advanced instruction has been given to a number of day students, as well as teaching of a less detailed character to evening classes. At present there are 19 day and 9 evening students. Two have been working for the ordinary B.Sc., and two for the honours B.Sc. degree in leather manufacture, and ten in different stages of the diploma course.

Among the past students of the department many are now occupying important positions both as proprietors and managers of leather works and in technical education, and, so far, no difficulty has been experienced by satisfactory students in finding suitable employment. The students have been drawn not only from the West Riding, but from all parts of Great Britain, from many of the British Colonies and India, and from the United States, as well as from France, Germany, Austria, Russia, Italy, Spain, and Belgium.

The building is admirably adapted for its purposes, and is probably second to none in the accommodation which it provides for its students. On the ground floor, in addition to a lecture-room and preparation-room, is a covered limeyard and tanhouse fitted with the necessary vats, drums, and paddles for complete tanning on a small scale. Adjoining this is a dye-house with the requisite appliances for moroccos and coloured leathers, and beyond, a large currying shop with shafting and abundant power, not only for driving the machinery which is provided, but for experimenting with new machines which are lent by machine makers for testing or exhibition. This room communicates, by a lift, with the laboratories of the first floor and the drying-rooms and store-rooms in the roof. While the ground floor is mostly devoted to experimental manufacture, the first floor is fitted for scientific study of the tanning process in all its various details. A large laboratory for students, with accommodation for about 30 pupils, a smaller research laboratory for the Professor and a few advanced students, a microscopic and bacteriological laboratory with provision for photomicrography, and a balance room and library are provided, together with a private room for the Professor. On the upper floor, in addition to drying and storage accommodation, is a well-lighted museum containing a large collection of

tanning materials and manufactured leathers to illustrate processes and defects of manufacture.

The course of study is intended, in the first instance, to familiarise students, both by information in lectures and by practical handling of the materials, with the details of the tanning process and the reasons why particular modes of treatment produce particular effects. This knowledge once gained, the student is in a position to judge of the causes of defects, and the changes which it is necessary to make to prevent or remedy them or to modify the leathers produced in such a way as may meet the requirements of the trade. Methods of chemical and microscopic analysis are also taught and practised for determining the purity and value of the various materials employed, and for checking their use in the different stages of the process. In the latter part of the course, students are encouraged to attempt the practical production of leathers in which they are interested, and to study the smaller details of the processes. Particular attention is paid to leather dyeing and the manufacture of coloured leathers, and small quantities of almost all kinds of leather of commercially saleable quality are produced.

In addition to actual teaching, the department undertakes a large amount of research work in connection with the practical production of leather and the scientific principles on which it is based, and the methods of analysis employed in controlling the purity of materials and the conduct of tanning processes. On these points much useful information has been freely given to the trade.

The scientific publication and research work of the department during last year is considerable and important. Among the papers of most practical interest may be mentioned those on various methods of control of tannery liquors, Mr. Bennett's paper on tannage with mimosa bark, which contains many points applicable to other materials, and a method for the detection of sulphite-cellulose liquors, which have become somewhat frequent constituents of mixed extracts.

HOME INDUSTRIES.

The Cotton Industry.—In March of this year the rate for middling American cotton was 4·93d., last week it had advanced to 7·95d. The upward movement has been influenced by Messrs. Neill Brothers' estimate of 10,600,000 to 11,000,000 bales, which compares with a crop for last season of 13,800,000 bales. The price of Egyptian cotton, too, has risen, until last week it was quoted at 11$\frac{5}{16}$d, it being thought in well-informed quarters that the yield will be less than last year. There seems ground for the fear that there may be a shortage of supplies next year. American producers of cotton are in a strong position to hold for even higher prices, as they have already sold enough cotton to meet their most pressing obligations, and they do not at present attach much importance to the proposed curtailment of production by cotton manufacturers. It is considered certain that the American cotton crop this season will be the smallest in proportion to the demand for many years. The Master Spinners' Federation Committee have recommended American spinners to continue running short time until December 6. They have only been working four days a week since the beginning of July, and owing to the appreciation in cotton values it is possible that the short time policy will be continued throughout the winter. Manufacturers claim that prices for the raw material have advanced to such a level that they are unable to produce finished goods to sell them on a profitable basis. A great meeting of members of the Master Spinners' Association is about to be held to discuss the whole situation and decide upon future policy, and it is suggested in some quarters that strong action should be taken by the Committee of the International Cotton Spinners' Federation with the object of stopping the manipulation of prices by speculators.

Wool.—Spinners who have merely looked on at the wool and top markets during the last month have cause for congratulation. The wool of merino quality bought at the last London auction will not make a super 60's top on the average under 2s. 6d., but tops of that quality can now be bought at Bradford for 2s. 2d., and for future delivery at 2s. 1d. Tops made out of wool recently imported into Bradford can only be sold at heavy loss, and the remark applies to wool at sea. There is no evidence that the downward tendency of prices in Australia has received a check. At the last auctions at Brisbane and Adelaide, when at each centre 33,000 bales were disposed of, prices were again lower. Mr. Bertrand Harmer, of Norwich, has just issued a circular to the clothing manufacturing trade, drawing attention to the decision of the Huddersfield Woollen Manufacturers' Association, not to make any allowance in future for patterns. The Association, which is composed of more than thirty large manufacturers in the Colne Valley district, has decided that all patterns above 9 in. by 27 in. will be charged for in full, and that no further allowance will be made for patterns in any form. Mr. Harmer suggests joint action, but this must be difficult to bring about. There is no representative body to defend the interests of the wholesale clothing industry.

The Outlook for Wheat.—The estimate of Russian grain crops recently issued by the Russian Ministry of Agriculture has naturally weakened wheat prices. Early in September the preliminary estimate of the Central Statistical Bureau at St. Petersburg placed the probable wheat crop at 73,250,000 quarters. The Ministry of Agriculture now puts it at 70,125,000 quarters for European Russia, and 11,300,000 quarters for the North Caucasian provinces. Adding the probable crop of Siberia, the total wheat production

for all Russia should be between 85,000,000 and 90,000,000 quarters. Taking the last five years, the Russian crop has averaged 75,000,000 quarters, and the exports 14,500,000 quarters. That gives something over 60,000,000 quarters as the home consumption, so that if the latest official estimate of this year's crop may be taken as accurate, there will be at least 25,000,000 quarters of wheat available for export, which would be a record export, that of 1904, which is so far the largest, being only 22,500,000 quarters. Nor is it only that the Russian wheat crop is far above the average. All the grain crops, with the exception of millet and buckwheat, promise to be larger this year than last, and than the average for the five years 1903-7. The unexpected size of the Russian wheat crop, and the ample present supplies of wheat, may be expected to keep prices easy, but a good deal will depend upon the extent of the Argentine crop. Reports speak well of the weather in that country, but it is feared that serious damage has been done to the wheat crop by locusts. The Australasian crop is expected to be a very large one.

The Australian Preference for British Goods.— At the time when under the Lyne tariff British exports to Australia were given a 5 per cent. preference, it was contended in this country, as, indeed, in Australia, that the preference was too small to have much effect in arresting the decrease in imports from Great Britain, which had been so noticeable in the trade returns of 1905-7. In order to show that this view has proved erroneous, during the visit of the Congress of Chambers of Commerce to Melbourne, in September, the Minister of Customs, Sir Robert Best, circulated a report intended to show that the decline has been arrested by the preference, but, as shown by the report, the "arrest" has been of the slightest. A series of percentage tables in the report shows 35 lines in which the percentage of British imports in 1908—when the preference was first in force—was less than in 1907, and 34 lines in which the percentage in 1903 exceeded that of 1907. The latter list includes confectionery, matches, apparel and attire, socks and stockings, electrical articles, earthenware, jewellery, and blankets. The list of goods in respect to which the 5 per cent. has proved ineffectual includes pickles, sauces, carpets, gloves, woollen piece goods, watches, mining machinery, silks and velvets, fancy goods, oils, bicycles, pianos, bags, stationery, leather, pipes, china, varnishes, and glass ware. The best that Sir Robert can say about the 5 per cent. as it affects British imports is that "the decrease in British importations in regard to the total of the particular items benefiting by preference has been arrested. Thus, comparing 1906 with 1905, the decrease was 0·3 per cent.; comparing 1907 with 1906, it was 2·46 per cent.; comparing 1908 with 1907 the decrease was 0·23 per cent." The effect of the Canadian preference upon British imports has been very much more marked, but then the preference has been more than six times as much.

Colliery Certificates. — The action brought by Messrs. J. and P. Coats, Ltd., against Mr. David Brown, and tried at the High Court of Justiciary, Edinburgh, will, it may be hoped, end the practice of collieries granting covering certificates for coal other than their own. It seems that in December, 1907, Messrs. Coats asked for tenders for 400 to 500 tons of best Bent splint coal for shipment to Barcelona, and accepted Messrs. Shields, Brown, and Ramsey's tender. In January 479 tons were shipped, and a certificate was sent to Messrs. Coats which stated: "This is to certify that we have shipped on board the s.s. *Diamond* at Grangemouth, to order of Messrs. Shields, Brown, and Ramsey, 479 tons of our best splint coal, all freshly wrought and well screened. The Bent Colliery Company, Limited, William New." It was afterwards discovered that only 30 tons of the coal was Bent splint coal. When Messrs. Coats and Co. discovered how they had been treated they decided to institute criminal proceedings. The manager of the Bent Colliery Company, in giving evidence, said that when Mr. Brown applied to him for a cargo of Bent coal he said that he could not let him have it, and they agreed that the only way out of the difficulty was to get some coal of the same quality, and the manager agreed to give his certificate for the coal. He issued the certificate, he said, in the belief that he was issuing a certificate for coal the same as their own. He admitted that he was not correct in describing the coal as "our best splint coal," but he looked upon the certificate not so much as a certificate of origin as a certificate of quality. It was shown in the evidence that there was no criminal intention in this, and that nobody suffered or profited by the substitution of one coal for another. The coal shipped, though it did not come up the shaft of the Bent Colliery, and was not literally Bent coal, came from the same seam, and was, for all practical purposes the same material. But the certificate was false. Messrs. Coats obtained full value for their money, but they did not obtain what they had ordered and they were told had been supplied to them. Mr. Brown did what is quite customary in the trade, he did it in good faith with no intention to injure anybody, but it often happens that certificates are issued in bad faith. In Mr. Brown's case the jury returned a verdict of guilty, recommending the respondent to the utmost leniency of the Court, and the prosecution did not move for sentence, and the Lord Justice Clerk was content to reprimand Mr. Brown formally and dismiss him from the bar, but anybody else now found guilty of the uttering of false colliery certificates will not be let off with an admonition. There is no harm in collieries making up cargoes with other coal than their own when they are short of material, or in authorising their immediate buyer to do so, but the condition precedent is that they inform the consignee of the fact, and obtain his acquiescence.

CORRESPONDENCE.

"THE COLORIST."

My attention has been called to your mention of "The Colorist" in your issue of September 17th, 1909. I am glad to find a disposition for fair play in your criticism, even though "The Colorist" is somewhat misrepresented therein, which no doubt arose from a too hasty reading of the book. This disposition for fair play on your part encourages me to hope that you will print the following reply to your review.

I do not refer to M. E. Chevreul as the latest authority on the subject of colour, as you have it: I distinctly state that his work of fifty-five years ago, which is erroneous, has permeated all colour literature (of an æsthetic nature), since his time.

I will admit that scientific students who investigate colour at the present time, have a knowledge of the Young-Helmholtz theory of colour. Their knowledge, however, is largely confined to theory and light, and few indeed have a practical knowledge of its application to pigments in painting and printing. On the other hand I venture to say that there is not one artist, art student, or colour printer in fifty in the United States, who has not read "The Colorist," but is imbued with the idea that the Brewster theory is the correct one. I am also quite inclined to believe that this is the case in England as well.

On page 12 of "The Colorist" will be found in paragraph 2:—"It is probable that what we call a primary colour is such only in relation to the organ of sight, the eye, and has no such function with light itself independently." On page 43 of "The Colorist" at the top of the page will be found the following:—"It may be well to state here that the minus colours advocated in this book as the primary colours for the subtractive method are primary in the sense that they cannot be duplicated or mixed subtractively by any other colours." Does not this successfully refute your statement that I "do not seem to appreciate that there can be no possible justification for speaking of any colours as being primary in a scientific sense"? And yet when we mention the exact triad which represent the fundamental or basic colour sensations of the eye, why should we not call them scientific?

You state that red, green, and violet can be made to reproduce all other colours; also that red, yellow, and blue as pigments may be made to do the same thing. You will find if you try the experiment that with pigments it is necessary to use not red, but a red purple; not blue as ordinarily conceived but a cyan blue (a greenish blue).

J. ARTHUR H. HATT.

Brooklyn, New York, October 9th, 1909.

EARLY STEAM NAVIGATION.

Frequent articles have appeared of late, generally in connexion with the Fulton Celebration in this country, like that by H. T. W. on "Early Steam Navigation," in your *Journal* of October 15th, which either do not mention the name of the first steamer to cross the Atlantic Ocean or give the credit to the *Savannah* (which only steamed four days of the entire trip). In the Historical Museum at Chicago is a model of the first steamship like those of the present, not an auxiliary steam and sail boat, that crossed the ocean—the *Royal William*. This steamship was built in the forties at Quebec, Canada, went to London under her own steam, having no other means of propulsion, and afterwards was sold to the Spanish Government.

The designer is unknown to the writer, but James Goudie, an articled shipwright* of Greenock, was sent to Quebec to superintend her construction. Mr. Goudie left the model which he constructed, and the plans and description of her construction, to the Chicago Historical Museum where the data are accessible. So after all England can claim the construction of the first steamship to cross the ocean.

ROBERT CRAIK MCLEAN,
Editor, "Western Architect."

Minneapolis, Oct. 25, 1909.

[The first ship to cross the Atlantic by the aid of steam was the *Savannah* in 1819. She started from the town of that name in Georgia on the 27th of April, and arrived at Liverpool on the 20th of June. Her engines were used on 18 days. In 1838 the *Sirius* and the *Great Western* crossed the Atlantic silmultaneously under steam alone. The former started from Cork on the 4th of April, and the latter from Liverpool on the 8th of that month. They arrived at New York on the 23rd of April.—ED.]

A CORRECTION.

In the notice of Colonel Gunn's "Report" in last Friday's issue of the *Journal*, the dislocation of two lines near the top of the 2nd column of page 1018 so obscures the etymologies there detailed, and the conclusions they seem to suggest, that I venture to reproduce the disordered sentences in their definite form, as follows:—"Speech is personified among the Hindus by the goddess Vach; the Latin "vacca," and "vox," &c.; the French *vache*; and the English vowel, advowson, &c., and the Hindustani *basha*, is but a variant of the word. The Sanskrit *gau*, "cow," "bull," "ox,"—and, in compound words, "Earth," as in *gau-chana* "a wheat (literally gram) field," reappears in the Persian *guftan*, to speak; in the Greek γαῖα, earth, and Gaea or Ge, the name of the personified Earth, and βοῦς, "cow," "ox," "bullock" [μόσχος], and in the plural "cattle," "kine," [the "bull" is ταῦρος]; in the Latin "bos;" and in the English cow, Scotice *coo*, bull, and bawl, &c.; "ox" having its root as some say in the Sanskrit *akshan*. Finally, the Hindu land measure *gau-vada*, or *gau-kos*, literally means the

* Goudie was given the last year of his apprenticeship to go to Quebec.

distance the lowing of "a cow pervades;" and the land meausure *gau-charma*, as much land as can be included within "a cow-hide" cut into strips [compare "hide," "plow," &c.]; and the linear measure *gau-karna*, used by Hindu handicraftsmen, literally means the length of "a cow's ear."

It is needless to correct obvious typographical and clerical errors; but while writing it may be as well to add that on the same page 1018, column 1, line 15 from the top, "required" should be "acquired"; and in line 7 from the bottom, "their euthanising us all," should read "our euthanising them all";—including ourselves, on becoming pensionaries.

GEORGE BIRDWOOD.

Nov. 6, 1909.

GENERAL NOTES.

BRITISH LIVE STOCK AND MACHINERY IN JAPAN.—In a memorandum on the subject of the Island of Hokkaido, Japan, Mr. E. F. Crowe, Commercial Attaché at Tokio, mentions that there are two important stock farms on the island, one belonging to the Prefecture, and one to the Department of Agriculture, in addition to two horse-breeding farms belonging to the Government. There are also some large private stock farms. The farm belonging to the Prefecture possesses 247 cattle, mostly Ayrshire and Shorthorn; the amount of butter produced annually is about 7,000 lbs., and the dairy machinery is of a London make. Most of the other machinery on the farm, however, is American. There are altogether 429 horses, comprising thoroughbreds, trotters, Anglo-Arabs, and Clydesdales, and about 200 Southdown and Cotswold sheep. The Japanese, however, do not care for mutton, and the director of the farm is doubtful whether sheep can be kept successfully for the sake of the wool alone. As regards pigs, the stock consists of 80 Berkshires, and experiments are being made in ham-curing. Poultry are represented by Plymouth Rocks. The farm belonging to the Department of Agriculture possesses 80 Simmenthal cattle, 40 brown Swiss, and 50 Ayrshires, as well as 170 Southdown and Shropshire sheep. Mr. Crowe suggests that there is an opening for British machinery here if it were brought more to the notice of the directors and owners of these and other farms on the island. (Names and addresses can be ascertained, on application at the Office of the Board of Agriculture, 8, Whitehall-place, S.W.).

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 15...British Architects, 9, Conduit-street W., 8 p.m. Mr. H. Inigo Triggs, "The Planning and Laying-out of Public Places."

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. J. Garstang, "The Hittites: Progress and Research."

TUESDAY, Nov. 16...Sociological (at the HOUSE OF THE ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.), 8 p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on papers: 1. Messrs. J. Dalziel and J. Sayers, "The Single-Phase Electrification of the Heysham, Morecambe and Lancaster Branch of the Midland Railway." 2. Mr. Joshua Shaw, "The Equipment and Working-Results of the Mersey Railway under Steam and under Electric Traction." 3, Dr. Charles Augustus Harrison, C.E., "The Effect of Electrical Operation on the Permanent-way Maintenance of Railways, as illustrated on the Tynemouth Branches of the North-Eastern Railway."

Statistical (in the Theatre of the Royal United Service Institution, Whitehall, S.W.), 8 p.m. Address by the President, Sir J. A. Baines.

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. O. G. Pike, "Behind Birdland's Veil."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Hon. J. McCall, "Tasmania."

WEDNESDAY, Nov. 17.. ROYAL SOCIETY OF ARTS John-street, Adelphi, W.C., 8 p.m. Opening Address of the 156th Session by Sir William H. White, on "An Imperial Navy."

Meteorological, 25, Great George-street, S.W., 7½ p.m. 1. Mr. C. J. P. Cave, "Methods Employed for Observing Pilot Balloons." 2. Mr. W. Marriott, "Registering Balloon Ascents at Gloucester, June 24th and 25th, 1909," and other papers.

Microscopical, 20, Hanover-square, W., 8 p.m. Messrs. E. Heron-Allen and Arthur Garland, "The Recent and Fossil Foraminifera of the Shore-Sands of Selsey Bill, Sussex."

United Service Institution, Whitehall, S.W., 3 p.m. Captain Howard V. Knox, "Use of Ski, and Training of British Soldiers for Duties on Snow-clad Frontiers."

Child Study Society, 90, Buckingham Palace-road, S.W. Dr. W. C. Sullivan, "The Child Criminal."

Junior Engineers (at the Royal United Service Institution, Whitehall, S.W.), 8 p.m. Presidential Address by Engineer Vice-Admiral Henry J. Oram, "The Propelling Machinery of War Ships."

THURSDAY, Nov. 18...Illuminating Engineering Society (at the HOUSE OF THE ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.), 8 p.m. Inaugural Address by the President, Professor Silvanus P. Thompson.

Royal, Burlington-house, W., 4½ p.m.

Linnean, Burlington-house, W., 8 p.m.

Chemical, Burlington-house, W., 8½ p.m. 1. Messrs. B. D. W. Luff and F. S. Kipping, "The Resolution of Symmetrical Derivatives of Phosphoric Acid." 2. Messrs. M. Barrowcliff and F. Tutin, "The Configuration of Tropeine and γ-Tropeine and the Resolution of Atropine." 3. Miss I. Smedley, "Note on the Stereo-isomeric Modifications of $\alpha\beta$ Dibro-benzyl acetone."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. Percy Fitzgerald, "The First Printed Book."

Historical, 7, South-square, Gray's-inn, W.C., 8 p.m. Miss M. Morrison, "The Duc de Choiseul's Projects for the Invasion of England (1768-1770)."

FRIDAY, Nov. 19...Society of Women Journalists (at the HOUSE OF THE ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.), 8 p.m.

Architectural Association, 18, Tufton-street, S.W., 7½ p.m. Mr. C. R. Enock, "The Architecture of the Incas of Peru."

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. Mr. H. A. Humphrey, "An Internal-Combustion Pump."

SATURDAY, Nov. 20...Sanitary Institute, Nottingham. Discussion on "The Improvement of City Slums by Housing Reform."

CONTRIBUTIONS TO THE READING-ROOM.

The Council have to acknowledge, with thanks to the Proprietors, the receipt of the following Transactions of Societies and other Periodicals.

TRANSACTIONS, &c.

African Society, Journal.
American Academy of Arts and Sciences, Proceedings.
American Chemical Society, Journal.
American Institute of Architects, Bulletin.
American Institute of Electrical Engineers, Transactions.
American Institute of Mining Engineers, Transactions.
American Leather Chemists' Association, Journal.
American Philosophical Society, Proceedings and Transactions.
American Society of Civil Engineers, Transactions.
American Society of Mechanical Engineers, Transactions.
Architectural Association, Journal.
Association of Engineering Societies (American), Journal.
Australasian Association for the Advancement of Science, Report.
Australian Official Journal of Patents.
Bagnères-de-Bigorre, Société Ramond, Bulletin.
Bath and West of England Society, Journal.
British Association for the Advancement of Science, Report.
British Dental Association, Journal.
British Fire Prevention Committee, Publications.
British Horological Institute, Horological Journal.
Brussels, Société d'Etudes Coloniales, Bulletin.
———, Travaux Publics de Belgique, Annales.
Canada, Royal Society, Proceedings and Transactions.
Canadian Institute, Transactions.
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Canadian Society of Civil Engineers, Transactions.
Central Chamber of Agriculture, Agricultural Record.
Chartered Institute of Patent Agents, Transactions.
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Chemical Society, Journal.
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———, Field Museum of Natural History, Publications.
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Cleveland Institution of Engineers, Proceedings.
Cold Storage and Ice Association, Proceedings.
East India Association, Journal.
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Franklin Institute, Journal.
Geneva, Société des Arts, La Revue Polytechnique.
Geological Society, Quarterly Journal.
Glasgow, Royal Philosophical Society, Proceedings.
Haarlem, Koloniaal Museum, Bulletin.
Imperial Department of Agriculture for the West Indies, Publications.
Imperial Institute, Bulletin.
India, Geological Survey, Memoirs and Palæontologia Indica.
——, Government of, Agricultural Ledger.
Indian Meteorological Department, Monthly Weather Review.
Institute of Bankers, Journal.
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Institution of Civil Engineers of Ireland, Transactions.
Institution of Electrical Engineers, Journal.
Institution of Engineers and Shipbuilders in Scotland, Transactions.
Institution of Gas Engineers, Transactions.
Institution of Mechanical Engineers, Proceedings.
Institution of Mining and Metallurgy, Transactions.
Institution of Naval Architects, Transactions.
International Catalogue of Scientific Literature.
Iron and Steel Institute, Journal.
Japan, College of Science, Imperial University, Journal.
Japan Society, Transactions and Proceedings.
Junior Institution of Engineers, Record of Transactions.
Kew Gardens Bulletin.
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Linnean Society, Journal.
Lisbon, Sociedade de Geographia, Boletim.
Liverpool, Engineering Society, Transactions.

Liverpool, Institute of Commercial Research in the Tropics, Journal.
——— Literary and Philosophical Society, Proceedings.
London Chamber of Commerce, Journal.
Lyon, Société d'Agriculture, Sciences et Industrie, Annales.
Manchester Literary and Philosophical Society, Memoirs and Proceedings.
——— Municipal School of Technology, Journal.
——— Steam Users' Association, Reports.
Milan, Associazione Elettrotecnica Italiana, Atti.
Munich, Polytechnischer-Verein, Bayerisches Industrie-und-Gewerbeblatt.
National Indian Association, "The Indian Magazine and Review."
National Service League, Journal.
New South Wales, Institute of Architects, Journal.
———, Royal Society, Journal and Proceedings.
New York Academy of Sciences, Annals and Memoirs.
North-East Coast Institution of Engineers and Shipbuilders, Transactions.
Nova Scotian Institute of Science, Transactions.
Paris, Comité International des Poids et Mesures, Procès Verbaux.
——, Conservatoire National des Arts et Métiers, Annales.
——, Société d'Encouragement pour l'Industrie Nationale, Bulletin.
——, Société de Géographie Commerciale, Bulletin.
——, Société des Ingénieurs Civils, Mémoires.
——, Société Internationale des Electriciens, Bulletin.
——, Société Nationale d'Acclimatation de France, Bulletin.
Patent-office, Illustrated Official Journal.
Pennsylvania (Western), Engineers' Society of, Proceedings.
Philadelphia, Academy of Natural Sciences, Proceedings.
——— Engineers' Club, Proceedings.
Physical Society, Proceedings.
Quekett Microscopical Club, Journal.
Röntgen Society, Journal.
Royal Agricultural Society, Journal.
Royal Asiatic Society, Journal.
Royal Astronomical Society, Memoirs.
Royal Colonial Institute, Proceedings.
Royal Cornwall Polytechnic Society, Annual Report.
Royal Dublin Society, Proceedings and Transactions.
Royal Geographical Society, "The Geographical Journal."
Royal Horticultural Society, Journal.
Royal Institute of British Architects, Journal.
Royal Institution of Cornwall, Journal.
Royal Institution of Great Britain, Proceedings.
Royal Irish Academy, Transactions and Proceedings.
Royal Meteorological Society, Quarterly Journal and Record.
Royal National Life Boat Institution, "The Life Boat" and Annual Report.
Royal Photographic Society of Great Britain, "The Photographic Journal."
Royal Sanitary Institute, Journal.
Royal Scottish Society of Arts, Transactions.
Royal Society, Philosophical Transactions and Proceedings.
Royal Society of Edinburgh, Transactions and Proceedings.
Royal Statistical Society, Journal.
Royal United Service Institution, Journal.
Smithsonian Institution, Report and Publications.
Society of Antiquaries, Archæologia and Proceedings.
Society of Biblical Archæology, Proceedings.
Society of Chemical Industry, Journal.
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Society of Dyers and Colourists, Journal.
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South Wales Institute of Engineers, Proceedings.
Tramways and Light Railways Association, Official Circular.
Victoria Institute, Journal of the Transactions.
Wisconsin Academy of Sciences, Transactions.

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Weekly.

Amateur Photographer.
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American Machinist.
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Board of Trade Journal.
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British Architect.
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Chronicle (Montreal).
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Cosmos: Revue des Sciences
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Je m' instruis.
Journal of Gas Lighting.
Journal of Horticulture.
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Machinery Market.
Master Builder.
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Medical Press and Circular.
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Mining Journal.
Motor Car Journal.
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Timber News.
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Madrid Cientifico.
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Quinzaine Coloniale.
Railways (Calcutta).
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Architectural Review.
Arms and Explosives.
Art Craftsman.
Board of Agriculture Journal.
Brewers' Journal.
Britannia.
British Trade Journal.
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Caterer.
Cold Storage and Ice Trades Review.
Commercial America.
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Cooper's Vehicle Journal.
Co-partnership.
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Country and Town.
Decorator.
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Engineering Magazine.
Engineering Review.
Estate Magazine.
Ferro-Concrete.
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Gas and Oil Power.
Giornale del Genio Civile (Rome).
Ice and Cold Storage.
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Imperial Colonist.
Indian and Eastern Engineer.
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Investors Monthly Manual.
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Journal d'Hygiène.
Leather.
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Moniteur Scientifique.
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Paper Makers' Monthly Journal.
Philosophical Magazine.
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Bombay Gazette (Overland Summary).
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